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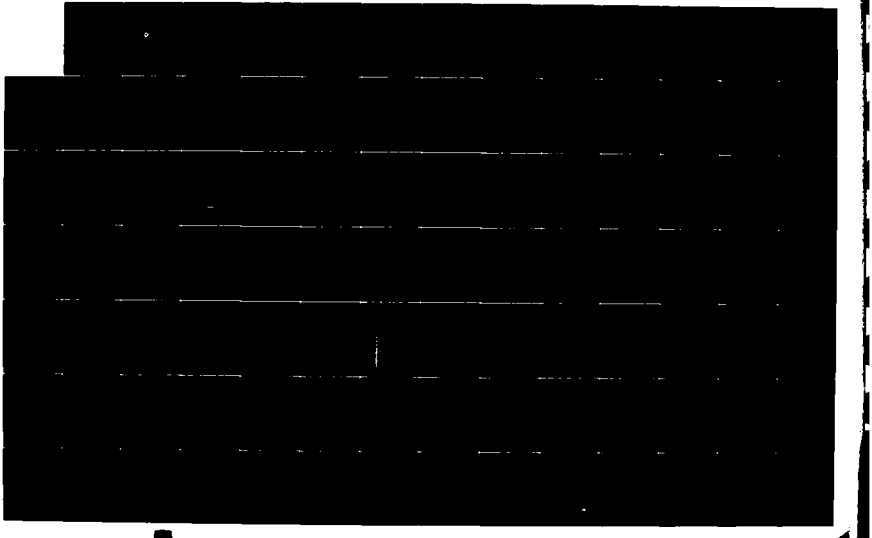

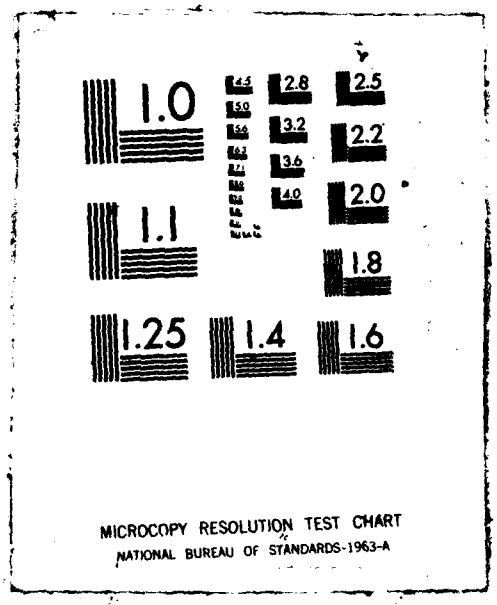
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REPORT NO. CG-TIS-0003-87

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UNITED STATES COAST GUARD LOCAL AREA NETWORK (LAN) STUDY

FEASIBILITY ANALYSIS REPORT

(FINAL)

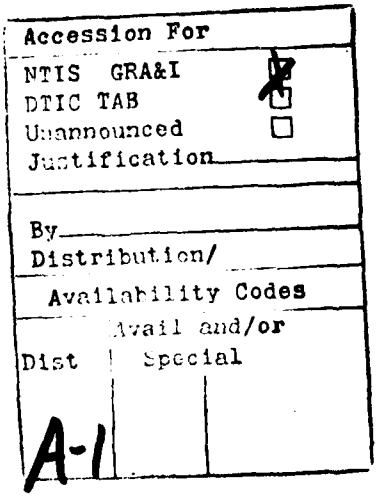
VOLUME I

FEBRUARY 1987

PREPARED FOR:

U.S. DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
WASHINGTON, D.C. 20593

NOTICE



Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
USCG-TTS-0003-87		

4. Title and Subtitle	5. Report Date
United States Coast Guard Local Area Network (LAN) Feasibility Analysis Report	February 1987
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
9. Performing Organization Name and Address Wilson Hill Associates, Inc. 1220 L Street, N.W. suite 200 Washington, DC 20005	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DTCG-23-85-A-50031
12. Sponsoring Agency Name and Address Department of Transportation U.S. Coast Guard Command, Control, and Communications	13. Type of Report and Period Covered FINAL REPORT
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Report documents Local Area Network (LAN) study. The study developed and evaluated LAN alternatives for U.S. Coast Guard Headquarters, Washington, DC. Alternatives studied were: Data Switch, Broadband, Baseband, and Hybrid (Broadband/Baseband). Study recommendation: Hybrid LAN. Volume I contains the main body of the report. Volume II contains detailed evaluation and costs relative to alternatives studied.

17. Key Words	18. Distribution Statement
Local Area Net Hybrid Baseband Broadband	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED		

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This is the final report for a Local Area Networking Feasibility Analysis conducted for U.S. Coast Guard Headquarters under Contract DTCG23-85-A-50031 (BOA), Task Order 85-0001. It updates and consolidates the findings of seven interim reports developed during the course of the study. There are two volumes: Volume I consists of the main body of the report and several short appendices while Volume II contains detailed appendices pertaining to alternative evaluation and costing.

ES.2 BACKGROUND AND SCOPE

The U.S. Coast Guard Headquarters building currently houses over 125 mini- and micro-computers, 1800 workstations and a variety of telecommunications equipment. Much of this is not interoperable because of equipment incompatibilities and the lack of interconnecting data networks. In May, 1985, a five month study evaluating the requirements for a Local Area Network (LAN) within USCG Headquarters was completed. The study:

- reviewed the number and kinds of communicating devices at USCG Headquarters (including USCG Standard Terminal Clusters and minicomputers);
- reviewed applications;
- developed a projected telecommunications workload; and, thereafter,
- developed a set of requirements for a LAN at USCG Headquarters.

This study was initiated early in FY '86 and concluded in the first quarter of FY '87. It was conducted with the advice and guidance of a USCG Local Area Network Feasibilty Study Working Group, who provided inputs at all steps in the study. The study began by updating the previously determined Headquarters LAN requirements and then:

- synthesized alternatives for USCG LAN's;
- developed technical, cost and implementation evaluation criteria;

- developed LAN conceptual designs for each selected alternatives;
- evaluated the alternatives; and concluded by
- performing a sensitivity analysis on the results of the analysis.

Conceptual designs were developed and an evaluation performed for four selected LAN alternatives. These were:

- Data Switch;
- Broadband;
- Baseband; and
- Hybrid (Broadband/Baseband).

Each design was tailored specifically to the USCG Headquarters building and reflected specified equipments, interconnection strategies and costs for USCG Headquarters.

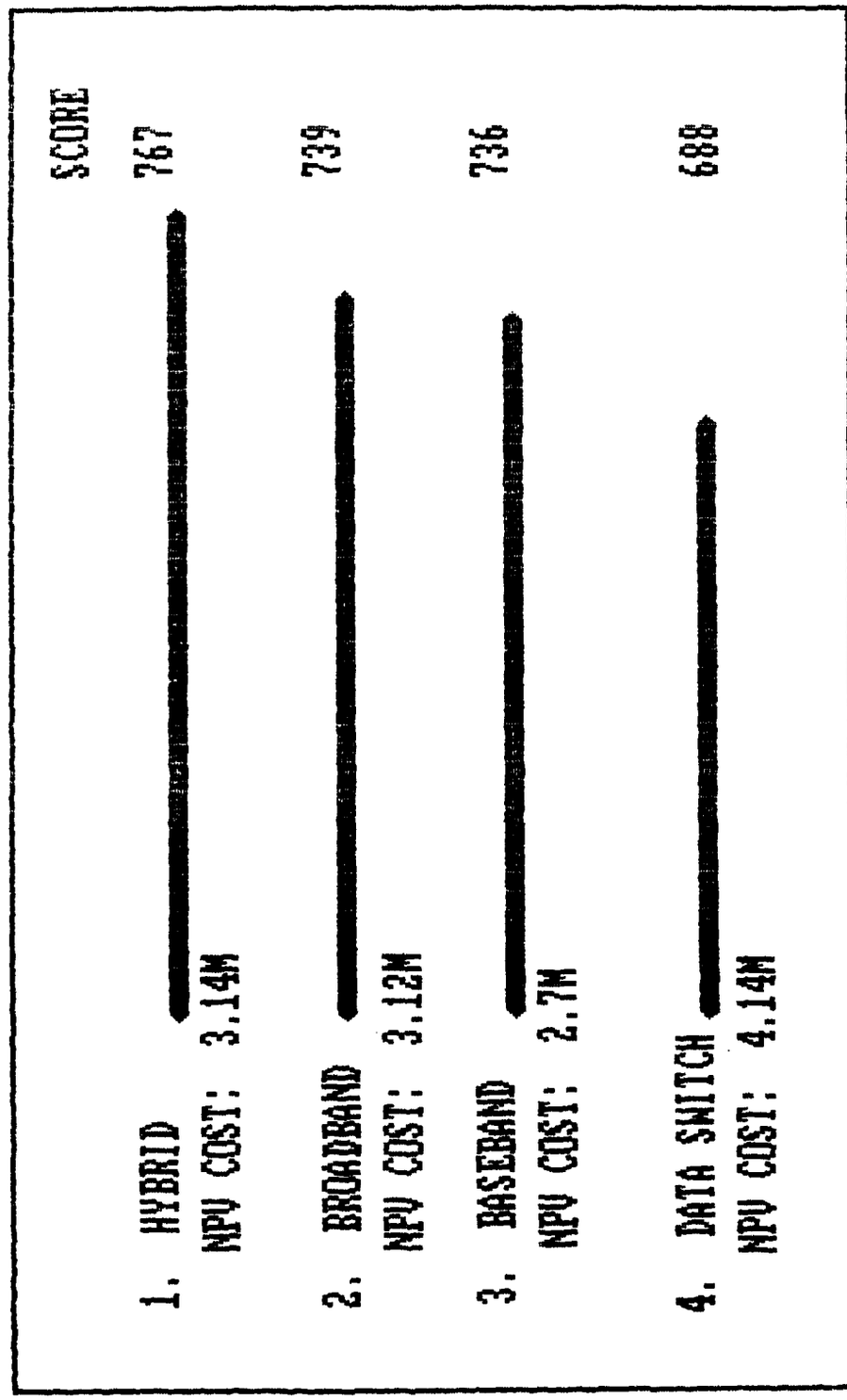
There were three sets of evaluation criteria: Technical, Implementation and Cost. As shown in Figures ES-1, the Technical Set and the Implementation Set were futher subdivided into Classes and Elements within Classes and weights were assigned to each Set, Class and Element. For example, the Technical Set a weight of 20 percent. Within the Technical Set, Headquarters Compatibility weighted 25 percent and so on. The total weight of any element was determined by multiplying Set Weight by Class Weight by Element Weight (e.g., .8 * .25 *.10 in the first line of Figures ES-1). Elements were scored on a range from 1 to 100 and the total possible score for all elements was normalized to 1,000 for ease in analyzing and depicting the study results.

For costs, the study began by projecting the growth in the number and kinds of communicating devices through the end of FY '91. The same growth projection was used for all alternatives. However, interconnection strategies were different depending on the alternative. Modules describing equipments connected to the LAN were developed and costs were then associated with each type of module. Details are shown in Volume II, Appendix H (Cost Module Charts) of this report. The cost modules were then used to develop the costs of implementing each candidate alternative conceptual design. A net present value analysis using a discount rate of ten percent was then performed. The results of the evaluation are summarized in Figure ES-2.

FIGURE ES-1 LAN CRITERIA ELEMENTS AND ASSIGNED WEIGHTS

CRITERIA SET	CRITERIA CLASS	CRITERIA ELEMENT	ELEMENT WT. VALUE	CLASS WT. VALUE	SET WT. VALUE
1. TECHNICAL	a. HEADQUARTERS COMPATIBILITY	HEADQUARTERS POLICIES AND GOALS	10	25	80
		EXISTING OPERATIONAL PROCEDURES	15		
		EXISTING HARDWARE	30		
		EXISTING COMMUNICATIONS SOFTWARE AND PROTOCOLS	25		
		EXISTING AND PLANNED HEADQUARTERS PHYSICAL FACILITIES	10		
		AVAILABLE PERSONNEL/ SUPPORT RESOURCES	10		
		-------- SUM --------	100		
	b. NETWORK SYSTEM PERFORMANCE	AVAILABILITY/ RELIABILITY	20	30	
		CONNECTIVITY/ CONCURRENCY	20		
		TRAFFIC-CARRYING CAPACITY	10		
		TRANSMISSION SPEED/ RESPONSE TIME	10		
		ERROR RATES	05		
		MEASUREMENT AND CONTROL CAPABILITY	10		
		SECURITY LEVELS ACHIEVABLE	15		
		FAULT CORRECTION FACILITY	10		
		-------- SUM --------	100		
	c. EASE OF USE	REQUIRED TRAINING	20	20	
		DAILY OPERATIONS	25		
		QUALITY OF DOCUMENTATION	20		
		ONGOING MAINTENANCE	10		
		CONTROL, MANAGEMENT, AND CONFIGURATION CAPABILITIES	25		
		-------- SUM --------	100		
	d. GROWTH CAPACITY	ACCOMODATION TO MOVES AND CHANGES	40	25	
		ALLOW INCORPORATION OF TECHNOLOGICAL ADVANCES	25		
		PROVIDE FOR GEOGRAPHIC EXPANSION	10		
		PROVIDE FOR INCREASED TRAFFIC FLOWS	10		
		OPEN ARCHITECTURE	15		
		-------- SUM --------	100	100	
2. IMPLEMENTATION	a. TIMING	CONGRUENCY WITH OTHER HEADQUARTERS-RELATED PLANS	40	60	20
		FIT WITHIN FISCAL BUDGET CYCLE	60		
		-------- SUM --------	100		
	b. INSTALLATION	DEMAND UPON HEADQUARTERS PERSONNEL	40	40	
		DEGREE OF DISRUPTION TO CRITICAL OPERATIONS	50		
		DURATION OF INSTALLATION/ TRANSITION	10		
		-------- SUM --------	100	100	100

FIGURE ES-2 RESULTS OF THE EVALUATION



Next, a sensitivity analysis was performed on the evaluation results. Of the 29 criteria believed to be important in the selection of a Headquarters LAN at the beginning of this study, it developed that only a very few would actually impact the selection. The sensitivity analysis determined that;

- o there were no major differences between the Broadband and the Hybrid alternatives;
- o there were major differences in only 2 of 29 criteria between the Baseband and the Hybrid Alternatives; and that
- o there were major differences in only 8 of 29 criteria between the Data Switch and the Hybrid Alternatives.

The differences are summarized in Figure ES-3 and Figure ES-4. It should also be noted that, in areas where major differences were found, that there are sound, technical reasons for the relative differences in score.

In terms of cost, the sensitivity analysis determined that the costs results:

- o were not sensitive to the number of communicating devices or growth projections (number and growth were the same for all alternatives);
- o were most sensitive to the mix and total number of high, medium and low speed lines directly connected to each networking alternative (i.e., devices that do not go through a host controller); and that
- o the cost difference between the Data Switch and the Hybrid Alternatives is most sensitive to the number of high speed lines used.

The Hybrid Alternative was the highest ranked and the Data Switch Alternative was the lowest ranked in the technical evaluation. The Data Switch Alternative was the highest in cost while the next highest was the Hybrid Alternative. In terms of cost, the sensitivity analysis determined that if the number of high speed lines to the Data Switch was increased in FY '91 to match the number of high speed lines in the Hybrid Alternative, the Net Present Value (NPV) of the Data Switch Alternative would approximately double. Conversely, to bring the Data Switch NPV down to that

FIGURE ES-3

SENSITIVITY ANALYSIS
BASEBAND VS. HYBRID

CRITERIA	WEIGHT	BASE BAND	HYBRID	DIFF.
GROWTH: Accomodation to moves and changes.	8%	60	72	12
COMPATIBILITY with existing hardware.	6%	36	48	12
ALL OTHER 27 criteria	86%	640	647	7
Total Points		736	767	31

FIGURE ES-4

SENSITIVITY ANALYSIS
DATA SWITCH VS. HYBRID

CRITERIA	WEIGHT	DATA SWITCH	HYBRID	DIFF.
GROWTH: Accomodation to moves and changes.	8%	60	72	12
COMPATIBILITY with existing hardware.	6%	30	48	18
GROWTH: Ability to include technological advances.	5%	25	45	20
PERFORMANCE: connectivity and concurrency.	4.8%	24	38	14
GROWTH: Open architecture.	3%	14	26	12
PERFORMANCE: Traffic carrying capacity.	2.4%	16	24	8
COMPATIBILITY with existing and planned physical facilities.	2%	18	10	-8
GROWTH: Provide for increased traffic flows.	2%	12	20	8
ALL OTHER 21 criteria	66.8%	489	484	-5
Total Points		688	767	79

of the Hybrid NPV, 300 high speed lines would have to be removed and the workstations associated with those lines would have to be connected through host controllers. In this case, performance of the Hybrid Alternative would probably be unacceptable.

Therefore, the study team recommends the Hybrid (Broadband/ Baseband) Alternative for implementing a USCG Headquarters LAN. This alternative has the highest technical and implementation score. When compared to the Data Switch Alternative, the costs are not as sensitive to the mix and total number of lines. The NPV cost of the Hybrid Alternative is within approximately 16% of the lowest cost alternative. Finally, the Hybrid Alternative provides the greatest flexibility to adapt to changing conditions while using in-place (or planned) technologies to implement the LAN.

This concludes the executive summary. The remainder of this report provides details on the Local Area Networking Feasibility Study conducted for U.S. Coast Guard Headquarters.

CHAPTER 1. INTRODUCTION

1.1 OVERVIEW

The United States Coast Guard Headquarters currently houses an array of more than 125 mini- and micro-computers, 1800 workstations and a variety of telecommunications equipment in the Transpoint Building in Washington, D.C. (see Figure 1-1). Much of this equipment is not interoperable because of technical incompatibilities and/or the absence of interconnecting electronic communications media.

In order to undertake an examination of the opportunities, costs and feasibility of furnishing a means of providing interoperability among computers, workstations and peripheral equipment, the USCG Headquarters requested Wilson Hill Associates, Inc., to initiate a study entitled "USCG Headquarters Local Area Network (LAN) Requirements Analysis" under contract DTFA-01-83-Y-30511. This study was completed on May 1, 1985.

A second study, documented herein, entitled "USCG Headquarters Local Area Network (LAN) Feasibility Analysis", was begun September 30, 1985. It is based upon the updated Requirements Analysis. Figure 1-1 contains the updated communication equipment inventory and projections information, including that for the newly organized Offices of Readiness and Reserve (G-R) and Acquisitions (G-A).

1.2 PURPOSE OF THE STUDY

The Requirements Analysis answered the following questions regarding Headquarters computers and workstations:

1. What telecommunications devices, i.e. host/controllers and workstations, does the Headquarters have now, and what type of applications are they used for?

2. What local and external telecommunications does Headquarters need through the 1990s and what types of applications are projected to be used?

The Feasibility Analysis updated the Requirements Analysis findings and defined four LAN alternative conceptual designs which are feasible based on technical, implementation and cost criteria to fulfill Headquarters' near and long term needs. The Feasibility Analysis also identifies the preferred alternative for implementation and the rationale for that selection.

FIGURE 1-1
COAST GUARD HEADQUARTERS
HOST/CONTROLLER AND WORKSTATION DISTRIBUTION

H.Q. OFFICES	1986 - 88							1990**						
	STANDARD TERMINAL		WANG		MINI COMPUTER		OTHER TERMINALS***	STANDARD TERMINAL		WANG		MINI COMPUTER		OTHER TERMINALS***
	H/C	WS*	H/C	WS*	H/C	WS*	WS*	H/C	WS*	H/C	WS*	H/C	WS*	WS*
A - ACQUISITION	8	50	0	0	1	40	50	8	50	0	0	1	40	50
B - BOATING	0	1	1	70	0	0	15	0	1	1	80	0	0	20
C - CHIEF STAFF	16	130	1	3	0	0	15	18	180	0	0	0	0	20
D - RESEARCH & DEV.	0	0	1	20	1	25	35	0	0	1	20	1	25	40
E - ENGINEERING	7	65	2	35	1	35	20	7	65	2	35	1	20	25
F - COMPTROLLER	18	180	1	15	1	10	15	20	200	0	0	0	0	20
K - HEALTH SERVICES	6	70	0	0	1	5	0	6	70	0	0	1	5	0
L - LEGAL	0	1	2	50	0	0	0	0	3	3	60	0	0	0
M - MERCHANT MAR. SAF.	2	35	2	135	0	0	4	2	40	2	150	0	0	10
N - NAVIGATION	6	65	0	0	0	0	0	6	65	0	0	0	0	0
O - OPERATIONS	15	150	0	0	1	10	10	16	165	0	0	0	0	10
P - PERSONNEL	4	40	1	70	1	70	50	5	50	1	80	1	70	100
R - READY & RESERVE	4	40	0	0	2	10	0	4	50	0	0	2	10	0
T - COM., CONT. & COM.	18	185	1	15	0	0	30	21	210	0	0	0	0	20
W - MAR. ENV. & SYS	2	10	0	50	2	20	5	2	15	0	50	2	35	10
TOTALS**	106	1022	12	463	11	225	249	115	1184	10	475	9	205	325
ADJUSTED TOTALS	106	997	12	463	11	205	224	115	1159	10	475	9	185	300
TOTAL H/C				129							134			
ADJUSTED TOTAL WS				1089							2119			

* WS INVENTORY ABOVE 5 ROUNDED TO NEAREST 5
** OVERALL TOTALS ADJUSTED TO REFLECT THE INVENTORY FOR OFFICE OF ACQUISITIONS (50%) FROM OTHER OFFICES
*** DOES NOT INCLUDE PORTABLE WORKSTATIONS

1.3 SCOPE OF THE STUDY

The scope of the Feasibility Analysis is to:

- Update, review, categorize and rank the user and system requirements identified by the Requirements Analysis Study;
- Establish qualitative criteria for the design and evaluation of alternative LAN configurations;
- Compile cost and performance data for LAN technologies that are appropriate to the Headquarters environment;
- Establish a methodology and quantitative scoring criteria with which to evaluate alternative LANs;
- Synthesize feasible LAN designs;
- Analyze, refine and select feasible LAN designs using the established methodology and scoring criteria; and to
- Perform a cost effectiveness analysis of the preferred alternative.

1.4 REPORT ORGANIZATION

The report comprises two volumes, with Volume I being the main body. For convenience, because of their large sizes, Appendices G and H are contained in Volume II.

Volume I is introduced by the Executive Summary, which briefly describes the Feasibility Report contents for readers who need to quickly grasp the report essentials without reading it in its entirety.

Following the Executive Summary and the introductory first chapter, Chapter 2 presents an overview of the system analysis methodology used in conducting the Feasibility Analysis. Chapter 3 explains the user and system requirements and their basic importance to the ensuing chapters.

Chapter 4 describes the criteria used to analyze and score the various LAN alternatives, while Chapters 5 and 6 describe the four selected LAN alternatives, how they were analyzed and refined, and the results of the analyses.

Costing information is concentrated in Chapter 7. The four selected LAN alternatives are compared in Chapter 8 and the sensitivity analysis is described in Chapter 9.

The Feasibility Analysis conclusions are found at the end of the report in Chapter 10.

Seven interim reports, listed below, were produced during the study. The data contained in them has been incorporated into the body of this report.

1. Rank Order of User and System Requirements. Contains the updated user and system requirements originally identified in the Requirements Analysis.

2. Qualitative Criteria For Design and Evaluation of Alternative LANs. Identifies the cost and weighted technical and implementation criteria used to evaluate the alternative LAN configurations.

3. Cost and Performance Data. Identifies the interim cost and performance parameters of the basic LAN technologies under consideration: Data Switch (DS), Baseband (bb), and Broadband (BB).

4. Methodology and Qualitative Criteria for Evaluating LANs. Describes the evaluation methodology, definitions, and quantitative scoring procedures proposed to rate alternative LAN conceptual designs for Headquarters. It includes:

   a. a structured, defined list of evaluation criteria;

   b. a rating scale;

   c. a weighting schema or methodology; and

   d. candidate LAN criteria weights.

5. Block Diagrams of Alternative LAN Designs. Describes the process used to select the four alternative LAN conceptual designs as one which involves iterative synthesis and analysis activities. In addition, it contains floor and building block diagrams of each of the four alternative LAN conceptual designs.

6. Preliminary Analysis for Competitive Range. Describes the screening process utilized to refine the set of feasible LAN alternatives presented in the fifth interim deliverable.

7. Cost and Sensitivity Analysis. Presents results of the technical and implementation evaluation and cost analysis of the four feasible Headquarters alternative LAN conceptual designs.

The seven interim deliverables document the structured, step-by-step development of the USCG LAN Study Feasibility Analysis activities. They represent the logical, incremental results of the tasks set forth in the Statement of Work (SOW).

CHAPTER 2. SYSTEM ANALYSIS APPROACH

2.1 OVERVIEW

This chapter describes the system analysis methodology used in conducting the Feasibility Analysis.

2.2 METHODOLOGY

2.2.1 Developed User and System Requirements

The information compiled in the Requirements Analysis was updated by interviews with Coast Guard personnel at the various offices of the Headquarters. The interviews were preceded by distribution of Interview Requirements Update Packets applicable to each office (see Appendix B). Requirements were assigned one of three priorities: 1) mandatory, 2) highly desirable, or 3) important but not essential (see Chapter 3).

2.2.2 Developed Evaluation Criteria and Weights

The qualitative technical, cost and implementation criteria used to evaluate the alternative LAN configurations were developed. In addition, the evaluation methodology, definitions and quantitative scoring procedures were defined.

Based on surveys performed for each office, 33 system requirements were identified and grouped into three major categories. These are: 1) Technical; 2) Cost; and 3) Implementation. See Chapter 4.

2.2.3 Developed Alternative LAN Architectures

Four alternative local area network conceptual designs were selected through an iterative process, described below and presented graphically in Figure 2-1. The process is divided into two major activities: synthesis and analysis. In practice, the process does not neatly separate into distinct activities; instead, it is both interactive and iterative (see Chapter 5).

2.2.3.1 Synthesis of Data

The selection process began with the first project deliverable, Rank Order User and System Requirements (see Chapter 3), as shown in block I of Figure 2-1. User and system (network) requirements were derived from existing and projected utilization of host/controllers and workstations, in addition to data communication applications such as electronic mail, messaging and the downloading of files.

User requirements were evaluated against technology available (block IIIA) after reviewing products of major vendors. Candidate alternatives were then reevaluated against the requirements (block V), and reconfigured and considered for further evaluation (block IV).

2.2.3.2 Analysis of Data

Candidate alternative LAN configurations were evaluated using the qualitative criteria described in Chapter 4 (block II of Figure 2-1). The criteria were also matched against the candidate alternative configurations (block V of Figure 2-1). The criteria selected for evaluation of alternative Headquarters LANs were divided into three sets: Technical, Cost, and Implementation. These criteria represent the set of most significant factors that Coast Guard management might use to select a local area network for Headquarters. Cost and performance data (block IIIB of Figure 2-1) for the candidate alternatives were compiled through literature reviews and interviews of key LAN vendor personnel. The results of this phase of the analysis are contained in Chapters 4 and 7.

2.2.4 Evaluated Each Alternative

As the alternatives selected for evaluation evolved, various other potential alternatives were screened. Some were eliminated, in whole or in part, if they did not appear to be within the competitive range either technically or financially. The process of building and screening LAN alternatives occurred concurrently. See Chapters 5 and 6.

2.3 ALTERNATIVE LAN DESIGNS SELECTED FOR EVALUATION

The four alternative LAN conceptual designs selected are:

Alternative 1 - Data Switch (DS)

Alternative 2 - Baseband (bb)

Alternative 3 - Broadband (BB)

Alternative 4 - Hybrid (Bb)

Each of the alternatives has an abbreviation: DS, bb, BB, and Bb, which are used throughout the report. Each of the alternatives is explained in detail in Chapter 5.

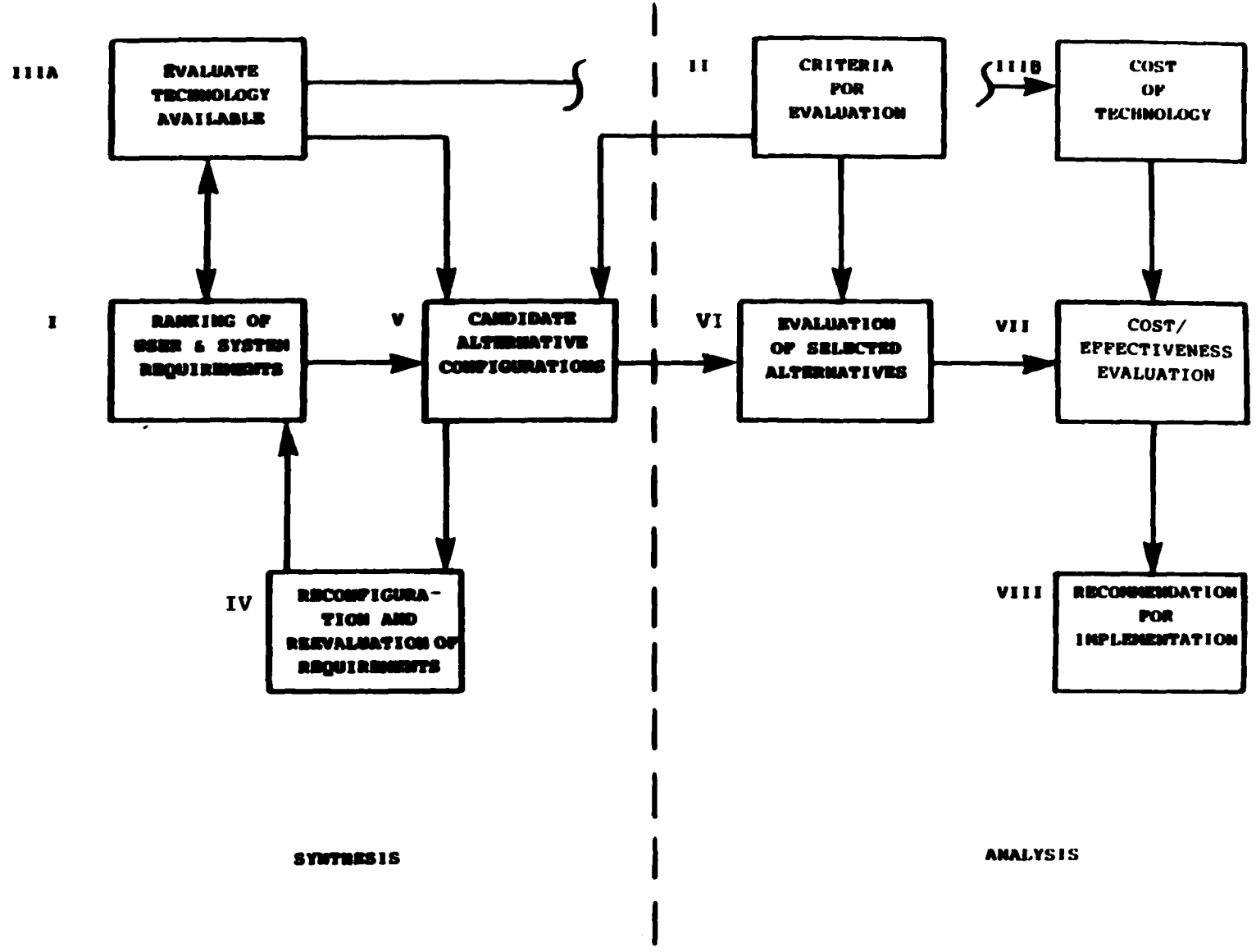


FIGURE 2-1. FEASIBILITY STUDY-METHODOLOGY OVERVIEW

2.4 COST ANALYSIS

2.4.1 Costing Methodology

Each alternative has been costed to determine its net present value (NPV) for a seven year period, from fiscal 1988 through fiscal 1994. NPV is a method of evaluating alternative ways of acquiring an asset. This technique utilizes the time value of money theory (i.e., a dollar today has a greater value than the same dollar in the future). Although different options of acquisition produce different savings (cash inflows) and expenditures (cash outflows) at different times during an analysis period, this financial technique allows all cash flows to be returned to a common time base, providing a single dollar cost in today's (1986) dollars for each alternative.

An integral part of this technique is the discount rate (net present value rate) used to return cash flow to the current time. For this study the discount rate represents the government's cost of funds for acquiring resources. The rate used in this analysis is 10%, which is consistent with OMB Circular A-94.

Figure 2-2 depicts the costing process. The process consists of six major activities:

1. Group major Headquarters data communication systems into modules and determine module cost.

2. Establish a migration or growth schedule over the years for each alternative.

3. Prepare detailed and summary annual module cost charts for each alternative, incorporating the migration schedule and module cost for each.

4. Integrate network acquisition and annual recurring costs.

5. Summarize annual costs for each alternative into acquisition and recurring categories, and determine net present value (NPV).

6. Compare net present value results of the four alternatives.

Appendix H (in Volume II of the Feasibility Analysis) contains Cost Module Charts. These charts depict the major cost components that comprise each module's cost. The costing process applied to each alternative is contained in Chapter 7. Principal cost assumptions are contained in Appendix F.

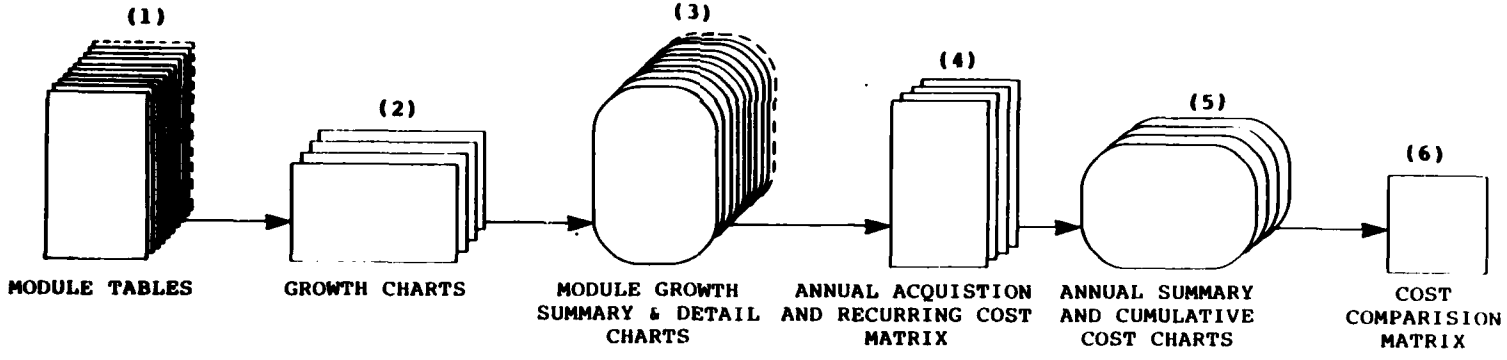


FIGURE 2-2. ALTERNATIVE LAN CONCEPTUAL DESIGN-COSTING METHODOLOGY

2.5 MODIFIED ASSUMPTIONS, CRITERIA, AND ALTERNATIVE TECHNICAL APPROACHES

Initial alternative technical approaches were modified by the previously described synthesis/analysis methodology. Initial assumptions and criteria were modified by additional reviews with the USCG.

2.6 REITERATED THE EVALUATION PROCESS

The evaluation process was repeated as often as required to refine the results. This was also done to enhance the reliability of results.

2.7 USCG LAN WORKING GROUP

The USCG created a LAN Working Group consisting of personnel from offices with particular interest in a LAN or having unique management or technical expertise. Appendix A lists the members of the Working Group during various phases of the analysis.

Wilson Hill met frequently with the USCG Working Group to exchange information, review activities and deliverables, listen to vendor and other presentations, and to offer guidance, suggestions and comments. Other USCG Headquarters personnel attended certain meetings and presentations as appropriate.

The following LAN/data switch vendor presentations were made by the individuals indicated:

- Bridge Communications, Inc. (R. Stark)
- C3, Inc. (M. Gammil)
- Micom, Inc. (C. Megelich)
- Northern Telecom, Inc., (Scheduled NTI consultants' seminar and interviews)
- Sytek, Inc. (D. Kohler)
- 3COM, Inc. (J. Moses)
- 3M, Inc. (W. Reil)
- Ungermann-Bass, Inc. (D. Corner)
- Wang Laboratories, Inc. (M. Grisby)

Information was compiled on the networking capabilities and future plans of each of these companies, particularly C3, Inc. and Wang, which provide many of the workstations and cluster controllers at Coast Guard Headquarters. The interviews with Northern Telecom focused on the capabilities of its SL-100 PABX, which is the new Department of Transportation telephone system.

2.8 MODELS

Substantial use was made of computer modeling techniques. Lotus 1-2-3 was used in the costing models and to produce most of the tables. Lightyear was used on the evaluations. All hardware was IBM compatible. These models are available to perform additional study and testing of the four Alternative LAN conceptual designs.

CHAPTER 3. USER AND SYSTEM REQUIREMENTS

3.1 INTRODUCTION

This chapter reviews the revised user and system requirements for a Headquarters LAN. These were originally identified in the Requirements Analysis and updated by this Feasibility Study. It was mandatory that the various alternative LAN conceptual designs fulfill these requirements in order to satisfy USCG Headquarters LAN needs. If they did not, the LAN conceptual designs were rejected.

3.1.1 Background

The Requirements Analysis identified 33 major system requirements for a local area network at U.S. Coast Guard Headquarters. In addition, user requirements to interconnect approximately 2000 workstations and over 100 host/controllers were also identified.

The network requirements for Headquarters are dynamic. As more of the Headquarters personnel utilize workstations and as new procedures such as electronic mail, messaging, and downloading of files become more widespread, requirements for networking become more focused. This results in changes and/or refinements to the requirements.

The process of evolving and changing requirements is expected to be ongoing, given the continuing development of user applications at Headquarters and the constant changes occurring in telecommunications technology.

3.2 ANALYSIS AND RESULTS

Each of the original 13 offices participating in the Requirements Analysis was provided with a copy of the network requirements pertinent to that office. See Appendix B for the survey format employed. Representatives from each office were interviewed to ascertain and document requirements changes. Figure 1-1 in Chapter 1 presents the current hardware estimates, including the newly organized Offices of Acquisition (G-A) and Readiness and Reserve (G-R).

When comparing the original and updated requirements, there has been less than a one percent change in workstation projections for 1990 (1,977 versus 1,959) and less than half of a percent change in 1990 host/controller projections (116 versus 119). The most significant equipment change has been in projections for personal computers. The projection from 1990 has increased by almost 50% over original estimates (252 versus 188).

After completion of the Feasibility Analysis reviews of individual offices' requirements, the basic system requirements were grouped into seven major categories as follows:

1) General
2) Security and Privacy
3) Physical Coverage
4) System Compatibility
5) Performance
6) Operations and Maintenance
7) Growth

Each of the categories includes several classes of requirements; each requirement has been ranked according to one of the following priorities: mandatory, highly desirable, or important but not essential. Sixteen of the requirements are mandatory and 11 are highly desirable (see Table 3-1).

The most difficult requirement to ascertain with a high level of confidence is traffic. Traffic projections are divided into three linkages: within the Headquarters building, between Headquarters and the Nassif Building, and between Headquarters and other external locations. The traffic within Headquarters is further divided into two types: traffic within workstation clusters, and traffic that goes outside of cluster workstations to another cluster or to an external location.

The minimum traffic load requirement within the average workstation cluster during the peak hour is projected to be ½ - 1 MBPS in 1990. The aggregate traffic load requirement outside of Headquarters' clusters within the Transpoint Building is projected for 1990 to be a minimum of 1 MBPS during peak hours. Traffic requirement projections for 1990 across gateways external to Headquarters is projected to be 1 MBPS, with 50% of the external traffic estimated to go to the Transportation Computer Center in the Nassif Building and 50% to other external locations.

3.3 SUMMARY

The Requirements Analysis identified 33 individual requirements for installation of a local area network at U.S. Coast Guard Headquarters. During the Feasibility Analysis, these requirements were reviewed by individual offices within the Coast Guard; were divided into a number of classes, grouped into seven major categories; and were ranked as either mandatory, highly desirable, or important but not essential.

Table 3-1 lists the requirements specified for the Headquarters LAN by category and class, and details the ranking given to each one. These requirements were later used to derive the evaluation criteria shown in Table 4-1. Those requirements

listed in this chapter were employed in determining the validity of various alternative LAN architectures, while those listed in Chapter 4 have been used to make comparisons between alternate LAN conceptual designs that had already been found valid.

Table 3-1: USCG HEADQUARTERS LAN USER AND SYSTEM REQUIREMENTS REVISED AND RANKED 11/28/85

REQUIREMENTS	HIGHEST PRIORITY MANDATORY	MEDIUM PRIORITY HIGHLY DESIRABLE	LOW PRIORITY *IMPORTANT/N.E.
I. GENERAL			
1. SUPPORT HQ INFORMATION AS AN INSTITUTIONAL RESOURCE	X		
2. ALLOW INTEROFFICE SHARING OF INFORMATION	X		
3. USABLE BY PERSONNEL WITH A WIDE RANGE OF TELEPROCESSING SOPHISTICATION	X		
4. SUPPORT LOW, MEDIUM AND HIGH SPEED COMMUNICATIONS (E.G. LOW VOLUME, HIGH SPEED INTERACTIVE MESSAGE SWITCHING; BULK DATA TRANSFER; AND HIGH VOLUME, LOW SPEED BATCH PROCESSING)	X		
II. SECURITY AND PRIVACY			
1. ALLOW ENTRY RESTRICTIONS TO DESIGNATED DATA BASES		X	
2. ENABLE TRANSMISSIONS TO BE ENCODED/ ENCRYPTED AS APPROVED BY THE NATIONAL SECURITY AGENCY			X
III. PHYSICAL COVERAGE			
1. ENABLE MOVES, INSTALLATION, AND CHANGES TO OCCUR EASILY BY PLUGGING IN AND UNPLUGGING COMMUNICATION CONNECTIONS	X		

* IMPORTANT/N.E.: IMPORTANT BUT NOT ESSENTIAL

Table 3-1: USCG HEADQUARTERS LAN USER AND SYSTEM REQUIREMENTS (CONT'D)

REQUIREMENTS	HIGHEST PRIORITY MANDATORY	MEDIUM PRIORITY HIGHLY DESIRABLE	LOW PRIORITY *IMPORTANT/N.E.
2. PROVIDE DISTRIBUTION TO THE ENTIRE HEADQUARTERS BUILDING AND OFFICE OF HEALTH SERVICES IN NASSIF BUILDING		X	
3. BE COMPATIBLE WITH REQUIREMENTS/ RESTRICTIONS IMPOSED BY BUILDING OWNER		X	
4. UTILIZE EXISTING HEAT, VENTILATION AND AIR CONDITIONING		X	
5. MEET FEDERAL AND LOCAL BUILDING CODES	X		
IV. SYSTEM COMPATIBILITY			
1. PROVIDE CONNECTIVITY BETWEEN:			
(A) WORKSTATIONS			X
(B) PERSONAL COMPUTERS AND HOST/ CONTROLLERS	X		
(C) 3270 IBM EMULATION WORKSTATIONS AND THE AMDAHL COMPUTER	X		
(D) STANDARD TERMINAL HOST/CONTROLLERS	X		
(E) WANG HOST/CONTROLLERS		X	
(F) DEC HOST/CONTROLLERS			X
(G) STANDARD TERMINAL AND WANG HOST/ CONTROLLERS		X	
(H) STANDARD TERMINAL AND OTHER (NON-WANG) HOST CONTROLLERS		X	
(I) WANG AND OTHER (NON-STANDARD TERMINAL) HOST CONTROLLERS		X	
(J) OTHER (NON-WANG OR STANDARD TERMINAL) HOST CONTROLLERS			X

Table 3-1: USCG HEADQUARTERS LAN USER AND SYSTEM REQUIREMENTS (CONT'D)

REQUIREMENTS	HIGHEST PRIORITY MANDATORY	MEDIUM PRIORITY HIGHLY DESIRABLE	LOW PRIORITY *IMPORTANT/N.E.
2. PROVIDE X.25 AND T1 GATEWAYS TO REMOTE LOCATIONS AND INTERCONNECT TO THE BUILDING PRIVATE BRANCH EXCHANGE, THE FEDERAL TELECOMMUNICATIONS SYSTEM AND THE PUBLIC SWITCHED NETWORK.	X		
V. PERFORMANCE			
1. SUPPORT A TRANSFER RATE OF:			
A) 1200 BPS	X		
B) .307 MBPS	INTRA CLUSTER		INTER CLUSTER
C) 2.56 MBPS			X
D) 4.27 MBPS	INTRA CLUSTER		INTER CLUSTER
E) 10.0 MBPS			X
2. SUPPORT			
(A) ASYNCHRONOUS COMMUNICATIONS	INTER CLUSTER		INTRA CLUSTER
(B) SYNCHRONOUS COMMUNICATIONS	X		
3. PROVIDE SPEED CONVERSION	INTER CLUSTER		INTRA CLUSTER
4. PROVIDE FOR MULTIPLE SESSION CONCURRENCY OF WORKSTATIONS		X	
5. PROVIDE AUTOMATED SHARED RESOURCE ALLOCATION		X	
6. INTRODUCE RESPONSE TIME DELAYS OF NO MORE THAN ONE SECOND FOR INTERACTIVE TRANSACTIONS	X		
7. HAVE AN UNCORRECTED BIT ERROR RATE OF 10^{-12} OR BETTER	X		

Table 3-1: USCG HEADQUARTERS LAN USER AND SYSTEM REQUIREMENTS (CONT'D)

REQUIREMENTS	HIGHEST PRIORITY MANDATORY	MEDIUM PRIORITY HIGHLY DESIRABLE	LOW PRIORITY *IMPORTANT/N.E.
VI. OPERATIONS AND MAINTENANCE			
1. PROVIDE ONGOING AVAILABILITY WITH MONTHLY SCHEDULED MAINTENANCE OF NO MORE THAN 2-3 HOURS	X		
2. DEGRADE GRACEFULLY IF FAILURE OCCURS		X	
3. HAVE A MEAN TIME TO FAILURE OF:			
(A) NETWORK - LESS THAN 10^5 HOURS		X	
(B) STATION - LESS THAN 10^4 HOURS		X	
4. HAVE A MEAN TIME TO REPAIR OF:			
(A) NETWORK - LESS THAN ONE HOUR		X	
(B) STATION - LESS THAN TWO HOURS		X	
5. HAVE A STANDARDIZED RECOVERY PROCEDURE	X		
6. REQUIRE NO MORE THAN 2 HOURS OF INDIVIDUAL USER TRAINING AND 2 DAYS OF SYSTEM OPERATOR TRAINING	X		
7. HAVE AVAILABLE USER AND SYSTEM LEVEL CONTRACT SUPPORT	X		
8. PROVIDE FOR A CONFIGURATION MANAGEMENT SYSTEM		X	
9. MAINTAIN NETWORK TRAFFIC AND USER STATISTICS		X	

Table 3-1: USCG HEADQUARTERS LAN USER AND SYSTEM REQUIREMENTS (CONT'D)

REQUIREMENTS	HIGHEST PRIORITY MANDATORY	MEDIUM PRIORITY HIGHLY DESIRABLE	LOW PRIORITY *IMPORTANT/N.E.
VII. GROWTH			
1. BE CAPABLE OF SERVING: A MINIMUM OF 2000 WORKSTATIONS, 500 OPERATING CONCURRENTLY; 120 OR MORE CLUSTERS, EACH SUPPORTED BY A HOST/CONTROLLER INTERCONNECTED BY GATEWAYS AND BRIDGES.	X		
2. ALLOW FOR THE INTERGRATION OF FUTURE TECHNOLOGIES INCLUDING GRAPHICS COMMUNICATIONS AND NEW COMMUNICATIONS PROTOCOLS.	X		
3. HANDLE A MINIMUM PEAK HOUR TRAFFIC LOAD OF: ½ - 1 MBPS WITHIN THE AVERAGE CLUSTER; 1 MBPS AGGREGATE, OUTSIDE OF CLUSTERS BUT WITHIN HEADQUARTERS; ½ MBPS ACROSS GATEWAYS EXTERNAL TO THE TRANSPORTATION COMPUTER CENTER, NASSIF BUILDING; AND ½ MBPS TO OTHER EXTERNAL LOCATIONS.	X		

CHAPTER 4. QUALITATIVE AND QUANTITATIVE DESIGN AND ANALYSIS CRITERIA

4.1 INTRODUCTION

This chapter describes the:

- Qualitative Criteria for Evaluation and Design of Alternative LANs; and the
- Methodology and Quantitative Criteria for Evaluating LANs.

4.2 QUALITATIVE CRITERIA FOR EVALUATION AND DESIGN OF ALTERNATIVE LANs

This section identifies the technical, cost and implementation criteria which were used to evaluate the alternative LAN configurations. Prior to evaluation, the criteria were assigned weighted values developed in conjunction with representatives of Headquarters.

4.2.1 Background

The formulation and selection of potential alternative LANs for Coast Guard Headquarters were based upon both user and system requirements. It was mandatory that all alternative conceptual designs under consideration meet the Headquarters requirements identified in the Requirements Analysis and revised in the Feasibility Analysis.

The process of evaluating alternative configurations required selection of criteria and a weighting methodology. Weights were given to each criterion to reflect its relative importance in regard to Headquarters requirements. The selection of criteria and their weights was, in part, driven by requirements; the criteria chosen and their individually assigned weights had to represent the Headquarters requirements.

The following paragraphs describe the criteria approach and criteria elements recommended for the Headquarters LAN Feasibility Analysis.

4.2.2 Analysis and Results

The criteria selected for evaluation of alternative Headquarters LANs are divided into three sets: Technical, Cost, and Implementation. As shown in Table 4-1, each set is further divided into classes and elements.

TABLE 4-1: USCG HEADQUARTERS LAN CRITERIA SCHEMA

SET	1 - TECHNICAL	2 - COST	3 - IMPLEMENTATION
CLASS	1) Compatibility 2) Performance 3) Ease of Use 4) Growth	1) Initial Capital 2) Conversion 3) Operations 4) Maintenance	1) Timing 2) Installation

ELEMENT Within each class, a number of elements make up each of the specific criteria.

During the process of evaluating alternative configurations, each criteria set was applied against each alternative LAN independently. That is, each of the four alternative conceptual designs received three independent ratings, one for each set of criteria. As in the case of each criterion, each set was also weighted to reflect its relative importance to Headquarters (user and system) requirements.

1. Technical Set

The technical set includes four classes of criteria: compatibility with the existing hardware, software, and facilities environment; performance; ease-of-use; and future growth capabilities for expandability and flexibility of the LAN. Each class, in turn, is defined in terms of its criteria.

A. Headquarters Compatibility - The elements of this class include the following:

1. Headquarters policies and goals
2. Existing operational procedures
3. Existing hardware (e.g. Standard Terminal Systems)
4. Existing communications software and protocols
5. Existing and planned Headquarters physical facilities
6. Available personnel and support resources

B. Network System Performance - The elements of this class include the following:

1. Availability/reliability
2. Connectivity/concurrency
3. Traffic-carrying capacity
4. Transmission speed/response time
5. Error rates (corrected and uncorrected)
6. Management and control capability
7. Security levels achievable
8. Fault correction facility.

C. Ease-of-Use - This class of criteria refers to the operational complexity of the LAN, from both the system operator and the end user's point of view. These criteria give a measure of both initial and continuing training requirements as well as of ongoing operating support. The elements of this class include the following:

1. Required training
2. Daily operations
3. Quality of documentation
4. Ongoing maintenance
5. Control, management, and configuration capabilities.

D. Growth Capacity - The elements of growth incorporate the capability to adapt to changing USCG Headquarters requirements as well as allowing incorporation of significant technological advances as they become available and established. The elements of this class include the following:

1. Accommodation of moves and changes
2. Allow technological advances to be incorporated
3. Provide for geographic expansion
4. Provide for increased traffic flow
5. Open architecture.

2. Cost/Financial Set

The second set of criteria consists of the cost/financial aspects of evaluation. This set of criteria includes the life-cycle cost elements of the LAN and is comprised of the following:

A. Initial capital costs
B. Conversion/cutover costs
C. Operational costs
D. Maintenance costs

The capital, conversion, and ongoing or annual costs listed above are further subdivided by the type of components that make up the cost (e.g. materials, labor, purchased services, etc.).

3. Implementation Set

The third set of criteria consists of factors that are neither technical nor costing in nature. Implementation consists of two major classes (Timing and Installation), detailed below:

A. Timing

1. Congruency with other Headquarters related plans
2. Fit within fiscal budget cycle.

B. Installation

1. Demand upon Headquarters personnel
2. Degree of disruption to critical operations
3. Duration of installation/transition.

4.2.3 Summary

An evaluation methodology that incorporates three sets of criteria was utilized for ranking alternative LAN for Coast Guard Headquarters. Details are contained in Appendix C of this report.

4.3 METHODOLOGY AND QUANTITATIVE CRITERIA FOR EVALUATING LANs

This section provides a description of the evaluation methodology, definitions, and quantitative scoring procedures used to rate alternative LAN conceptual designs for Headquarters. It includes: 1) a structured, defined list of evaluation criteria; 2) a rating scale; 3) a weighting schema or methodology; and 4) LAN criteria weights for Coast Guard Headquarters.

4.3.1 Background

A set of qualitative criteria for the evaluation of alternative LAN conceptual designs was prepared and submitted to the Coast Guard for review in the interim deliverable entitled "Qualitative Criteria for Design and Evaluation of Alternative LANs". In that document, three sets of criteria structured into classes and elements were described. Each set was defined to the element level. The criteria elements were derived from the Headquarters LAN requirements identified in the Requirements Analysis and were updated early in the Feasibility Analysis.

The U.S. Coast Guard Feasibility Study Working Group, through a series of work sessions with the Wilson Hill Study Team, assisted in refining the criteria definitions and categories. The joint team also established the weightings that were assigned to the elements and classes as well as to the three criteria sets (technical, implementation and cost/financial).

4.3.2 Analysis and Results

The analysis and results of the team effort are presented herein in five parts:

1) The structured criteria
2) The rating scale
3) The weighting methodology
4) Candidate weighted values applied to elements, classes and sets
5) Ranking Alternative LANs

4.3.2.1 Structured Criteria

There are a total of 33 elements for evaluation in the structured criteria. Twenty-four apply to technical areas, 5 to the implementation set and 4 to the cost/financial set.

The 29 criteria that are not cost related (technical and implementation) are subdivided into four and two classes, respectively, with the elements of each class being the fundamental units for evaluation. The hierarchy of these criteria was shown in Table 4-1. The hierarchy is utilized in Appendix C which also contains a brief description/definition of each of the criteria elements/classes.

The criteria within the cost/financial set are subdivided only to the class level. For this criteria set, the classes are the fundamental units for evaluation.

Each fundamental unit of the criteria was applied against each of the alternative LANs. The evaluation incorporated a weighting methodology that reflected the relative importance that USCG Headquarters gave to the various elements/classes of criteria.

4.3.2.2 Weighting Methodology and Assignment of Criteria Weighted Values

4.3.2.2.1 Technical and Implementation Criteria

A methodology of assigning weighted values to each of the criteria elements in the technical and implementation sets was used to estimate the relative worth of each element within its class. As shown in Table 4-2, the weighted value of each element in a class is normalized such that the total weighted value of all the elements in any one class adds up to 100%.

TABLE 4-2 LAN CRITERIA ELEMENTS AND ASSIGNED WEIGHTS

CRITERIA SET	CRITERIA CLASS	CRITERIA ELEMENT	ELEMENT WT. VALUE	CLASS WT. VALUE	SET WT. VALUE
1. TECHNICAL	a. HEADQUARTERS COMPATIBILITY	HEADQUARTERS POLICIES AND GOALS	10	25	80
		EXISTING OPERATIONAL PROCEDURES	15		
		EXISTING HARDWARE	30		
		EXISTING COMMUNICATIONS SOFTWARE AND PROTOCOLS	25		
		EXISTING AND PLANNED HEADQUARTERS PHYSICAL FACILITIES	10		
		AVAILABLE PERSONNEL/ SUPPORT RESOURCES	10		
		-------- SUM --------	100		
	b. NETWORK SYSTEM PERFORMANCE	AVAILABILITY/ RELIABILITY	20	30	
		CONNECTIVITY/ CONCURRENCY	20		
		TRAFFIC-CARRYING CAPACITY	10		
		TRANSMISSION SPEED/ RESPONSE TIME	10		
		ERROR RATES	05		
		MEASUREMENT AND CONTROL CAPABILITY	10		
		SECURITY LEVELS ACHIEVABLE	15		
		FAULT CORRECTION FACILITY	10		
		-------- SUM --------	100		
	c. EASE OF USE	REQUIRED TRAINING	20	20	
		DAILY OPERATIONS	25		
		QUALITY OF DOCUMENTATION	20		
		ONGOING MAINTENANCE	10		
		CONTROL, MANAGEMENT, AND CONFIGURATION CAPABILITIES	25		
		-------- SUM --------	100		
	d. GROWTH CAPACITY	ACCOMODATION TO MOVES AND CHANGES	40	25	
		ALLOW INCORPORATION OF TECHNOLOGICAL ADVANCES	25		
		PROVIDE FOR GEOGRAPHIC EXPANSION	10		
		PROVIDE FOR INCREASED TRAFFIC FLOWS	10		
		OPEN ARCHITECTURE	15		
		-------- SUM --------	100	100	
2. IMPLEMENTATION	a. TIMING	CONGRUENCY WITH OTHER HEADQUARTERS-RELATED PLANS	40	60	20
		FIT WITHIN FISCAL BUDGET CYCLE	60		
		-------- SUM --------	100		
	b. INSTALLATION	DEMAND UPON HEADQUARTERS PERSONNEL	40	40	
		DEGREE OF DISRUPTION TO CRITICAL OPERATIONS	50		
		DURATION OF INSTALLATION/ TRANSITION	10		
		-------- SUM --------	100	100	100

For example, the weighted values assigned to the eight elements making up the class "Network System Performance" in the technical set is as follows:

o	Availability/Reliability	- 20
o	Connectivity/Concurrency	- 20
o	Traffic-Carrying Capacity	- 10
o	Transmission Speed/Response Time	- 10
o	Error Rates	- 5
o	Measurement and Control Capacity	- 10
o	Security Levels Achievable	- 15
o	Fault Correction Facility	- 10
	Total	100%

This was done for each of the four classes in the technical set and for the two classes in the implementation set. The weighted values assigned to elements are shown in Appendix C.

The technical and implementation classes were each then assigned relative values within their respective sets. The same procedure applied between the elements within a class was also applied between the classes: the total weighted value of each class within a set is normalized to 100%. An identical process was used in determining the overall weighted value of both the technical and implementation sets. The complete weighted values for the technical and implementation sets for Coast Guard Headquarters are presented in Appendix C.

Within the technical set, for example, the class "Ease of Use" is given a weight of 20%, compared to 25% for "Headquarters Compatability", 30% for "Network System Performance" and 25% for "Growth Capacity".

A 60-40 weighting was assigned to the timing and installation classes, respectively, within the implementation set.

The relative weightings of the technical and implementation sets (80% technical vs. 20% implementation) are based upon the relative importance attached to the process of implementing a Headquarters LAN versus the technical characteristics of the LAN to be installed.

These candidate weighted values are based upon 1) the findings obtained by the Wilson Hill staff during discussions and interviews with Coast Guard personnel, 2) review sessions held with the working group, and 3) professional judgement of the analysis team.

4.3.2.2.2 Cost/Financial Set Criteria

The same procedure was used to assign weighted values to the cost/financial classes. These candidate values are shown in Table 4.3. The cost/financial criteria set is maintained separately and is not combined with the technical and implementation sets.

The cost/financial evaluation was based on single dollar values calculated for the acquisition and operation of a specific LAN. The single dollar value consists of capital and annual operating/maintenance costs over a specific time period (for this analysis, a 7-year cycle), with the stream of costs brought back to a single point in time. It also includes conversion/cutover expenses. This method takes into account a phased implementation and assumes a specific time value of money.

The complete cost value for capital, for example, was built up from the quantities and size of the various devices on the LAN, as well as from installation labor estimates.

4.3.2.2.3 Weighting Methodology In Perspective

The weighting methodology includes a weighted value system independent of any of the alternative LAN conceptual designs evaluated. The actual evaluation of alternative LANs was carried out after the conceptual designs were defined.

The end result of the process of developing weighted values for a set of criteria is a template (model) that is used to compare alternative LAN conceptual designs. This model allows the Working Group to change and adjust the relative values between elements, between classes and between sets. It also allows the addition and/or combination of different elements, classes or sets.

By applying each alternative LAN to the evaluation model, each LAN was given a quantitative score. This numeric score ranked the LANs relative to each other in terms of technical and implementation factors and, separately, in terms of cost/financial factors.

This chapter does not contain the actual evaluation of alternative LANs, but only a description of the value system used to numerically evaluate the alternative LAN systems. The evaluation of alternatives can be found in Chapter 6.

TABLE 4-3. LAN COST/FINANCIAL CRITERIA
WITH ASSIGNED
CANDIDATE WEIGHTED VALUES

CRITERIA SET	CRITERIA CLASS	CLASS RATING	CLASS WEIGHT
3. COST/FINANCIAL	a. ACQUISITION		40
	b. RECURRING		60
	****** SUM ******		100

4.3.2.2.4 Calculating A Score For An Alternative LAN

The technical and implementation evaluation consisted of first establishing the 33 individual criteria weights (see Figure 6-1). This, in addition to the scoring of the elements for each alternative, was done in coordination with the Working Group.

The maximum totalled weight for the 33 elements was 1000 (100%). The more closely the individual criteria element scores approach this figure, the more nearly they fulfill the requirement. The scores were totalled (e.g. Alternative 4 = 767) and compared to the weighting total (1767/1000). These alternative total scores were then put into rank order.

The cost evaluation consisted of calculating the annual (over 7 years) total allocation (acquisition and recurring) costs for the alternatives and calculating the net present value of each, which were then put into rank order.

The rank orders of the technical/implementation evaluations were compared to the rank order of alternative costs to formulate the conclusion as to the most appropriate conceptual design.

4.4 SUMMARY

This chapter has outlined the method by which the selected alternative conceptual LANs were numerically evaluated. The primary purpose of this evaluation methodology was to compare the alternatives in order to conclude which LAN is the most appropriate to meet the Headquarters requirements as defined in the Requirements Analysis.

CHAPTER 5. ALTERNATIVE LAN DESIGNS

5.1 INTRODUCTION

The methodology used to develop these alternatives and, thereafter, to perform a technical and cost evaluation was described in Chapter 2 of this report. This chapter provides, at a conceptual level of detail, a description of the four alternative LAN designs selected for evaluation and includes a narrative description of each alternative, block diagram depictions, and discussions relative to protocols and other issues regarding communication system standards.

The alternatives selected include a data switch network, a baseband configuration, a broadband architecture, and a hybrid of the baseband and broadband architectures. Each of these alternatives was determined to have the capacity to satisfy existing and projected U.S. Coast Guard Headquarters user and system data communication requirements.

Each of the four alternative LAN configuration conceptual designs is described in terms of its topology and switching and media characteristics, both within and between clusters. In addition, the overall configuration of each alternative LAN is characterized as having either primarily centralized or distributed switching. The central nodes, major external gateways and major assumptions are also described for each alternative.

Each alternative is graphically portrayed in block diagram format. As appropriate, the relation of each alternative to industry-wide standards is identified. The Working Group, together with the Wilson Hill Study Team, jointly defined the alternatives presented.

5.2 OVERVIEW

The synthesis and analysis process previously described in Chapter 2 resulted in the following four alternative conceptual LAN designs:

1. Data Switch (DS). A centralized switch utilizing a star topology. The voice/data PBX currently being installed in the Transpoint Building (Northern Telecom SL-100) will be used and supplemented with an enhanced data switch in the 1990's.

2. Baseband (bb). Distributed switching using a bus topology. Essentially an Ethernet local area network.

3. Broadband (BB). Employs distributed switching in a tree topology. Essentially a Wangnet local area network.

4. Hybrid (Bb). Distributed switching in a combination of a tree and bus topology. The backbone is Wangnet; the remainder, Ethernet.

These four conceptual designs are described in greater detail below. These are preceded by a discussion of the major assumptions underlying each of the alternatives.

5.3 EQUIPMENT ASSUMPTIONS AND PROJECTIONS COMMON TO ALL LAN ALTERNATIVE CONCEPTUAL DESIGNS.

Figure 1-1 in Chapter 1 contains the updated host/controller and workstation inventory and projections. Each of the alternative LAN conceptual designs is built around these figures.

A number of simplifying assumptions have been made about the aggregation of device types and their locations. It is fully understood that a significant number of office moves will have been undertaken by 1990. The model block diagram used for each alternative as a reference point for alternative comparison shown in Figure 5-1.

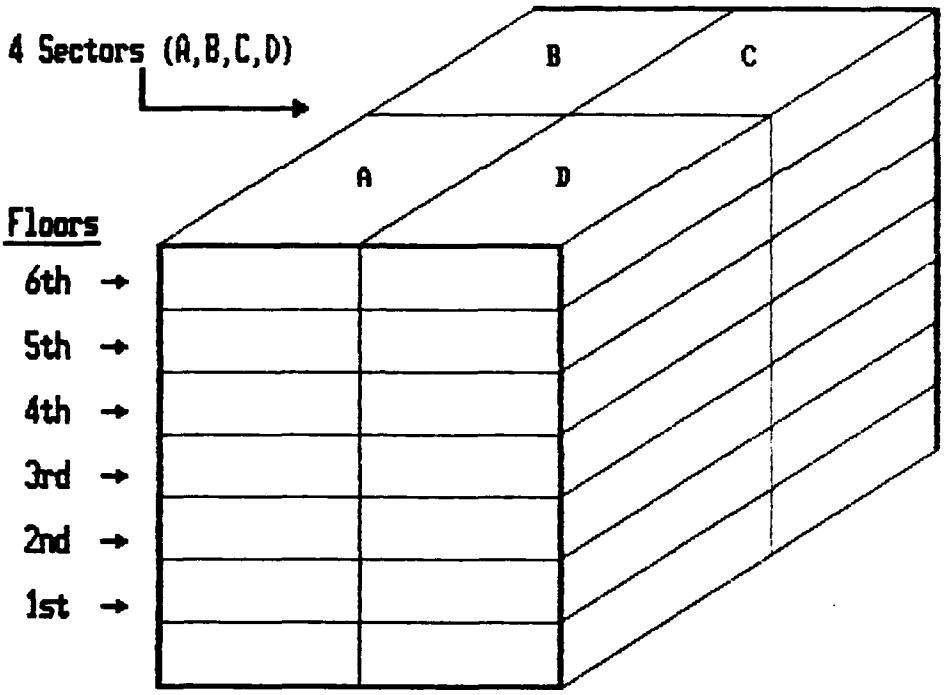
5.4 SL-100 DATA LINE USAGE ASSUMPTIONS COMMON TO ALL LAN ALTERNATIVE CONCEPTUAL DESIGNS

The SL-100 PBX installed in the Transpoint Building is included as part of each alternative LAN conceptual design. Figure 5-2 indicates the distribution of the up to 400 data lines by vendor, host/controller and workstation which will be available to the Coast Guard Headquarters on the SL-100/data switch.

For each of the alternatives, the 400 lines are used somewhat differently, but are generally assigned where the density of the required service is low or where a particular localized or non-standardized requirement exists. This approach enables the strength of each particular LAN alternative design to be best utilized and also minimizes or eliminates the need for minor variations and non-standardized interfaces in implementing the various sub-networks.

FIGURE 5-1

GEOGRAPHIC BLOCK DIAGRAM OF THE TRANSPOINT BUILDING
(U.S. COAST GUARD HEADQUARTERS)



NOTES:

- The building is divided into 24 sectors (6 floors by 4 sectors served by 6 wiring closets per floor).
- Four wiring closets per floor are used as distribution points and inter-floor connections.
- External access points are assumed to be located in the SL-100 switch room.

FIGURE 5-2. DATA LINE DISTRIBUTION ASSUMPTIONS/PROJECTIONS

DATA EQUIPMENT		PERIOD
VENDOR	TYPE	1986-88
STANDARD TERMINAL	HOST/ CONTROLLERS	20 (20%)
	WORKSTATION	200 (20%)
WANG	HOST/ CONTROLLERS	30 (100%; 3/HOST)
	WORKSTATION	0
MINIS o PRIME o DEC o HARRIS	HOST/ CONTROLLERS	30 (100%;4/HOST)
	WORKSTATION	70 (30%)
PERSONAL COMPUTERS	WORKSTATION	50 (30%)
ASSUMPTIONS/ NOTES		o 400 DATA LINES o REPLACE HARD WIRED AS MOVED/ ACCESSIBILITY TO MULTIPLE MINIS REQUIRED.

* IN ADDITION TO USE OF APPROXIMATELY 180 MODEMS USING VOICE LINES.

NUMBERS ROUNDED TO NEAREST TEN

5.5 GEOGRAPHICAL LAYOUT ASSUMPTIONS COMMON TO ALL LAN ALTERNATIVE CONCEPTUAL DESIGNS

For all alternatives, network architectures have been adapted to a common geographical layout of the Transpoint Building. Each floor of the building has been divided into four sections and subnetworks are contained in each sector. There are six floors and six existing wiring closets are available on each floor.

In order to maintain simplicity in this study, four of the six wiring closets per floor are used as the centers of distribution for that floor. All of the LAN conceptual designs use between- floor riser cables which also serve the central location of each LAN's network control center (NCC), head end and data switch center, in addition to the access or gateway point to the Nassif Building (where, for example, the USCG Office of Health Services is located) and the outside world.

These external access points are assumed to be located in the Northern Telecom SL-100 switch room for each of the four alternatives presented.

5.6 STANDARDS ISSUES COMMON TO ALL LAN ALTERNATIVE CONCEPTUAL DESIGNS

Protocols and standards for LANs include 1) those that apply internally to the local network for control and management, 2) those required for interfacing with attached devices and their software processes and applications, and 3) those that are necessary to exchange information between a LAN and another communications network. For each of the alternative conceptual LAN designs considered, and for the four formulated and selected for evaluation, adherence to standards is a major consideration.

Each alternative LAN reviewed for Coast Guard Headquarters incorporates standards that are widely recognized by such bodies as the International Organization for Standardization (ISO), or use protocols that have become de facto industry wide standards such as Xerox's Ethernet for baseband communications and X.25 for network exchanges. This includes standards for both internal and external connections.

The protocols and standards applicable to an alternative are identified. Some protocols and standards are common across the four, while others are specific to the architecture of an individual alternative. Alternatives include vendor-specific protocols where standards are not yet established. Where appropriate, the migration pathway specified for each alternative includes evolving from a vendor specific protocol to industry/ISO standardization.

All of the alternatives for evaluation include:

1. X.25 packet switched gateways to other networks;

2. T-1 digital transmission gateways;

3. A modem pool asynchronous gateway to the public data network;

4. 3270 synchronous emulation connectivity to the Transportation Computer Center; and

5. Gateways to the Defense Digital Network utilizing TCP/IP.

5.7 DETAILED DESCRIPTION OF LAN ALTERNATIVE CONCEPTUAL DESIGNS

5.7.1 Data Switch (DS) Conceptual Design 1: Centralized Star

5.7.1.1 Overview

The data switch fulfills the system and user requirements by employing centralized switching in a star topology (see Figure 5-3). The topology of switching and electronic media used within and between clusters are presented for Standard Terminal, Wang, PC and minicomputer host controllers and workstations. A block diagram of the Data Switch LAN is presented together with assumptions and a discussion of protocols and standards.

5.7.1.2 Assumptions and Description

Initially, data switching is furnished by the installation of a Northern Telecom SL-100 voice/data integrated PBX in the USCG Headquarters (Transpoint Building). The data line usage projections begin at up to 400 by 1987-88, rise to 1,000 by 1990 and over 1,500 by 1993-94 (see Figure 5-4). Sometime during the 1990s, usage is projected to be at a level which could degrade the service on the SL-100 integrated voice/data PBX. In this event, a substantial upgrade to the switch or the installation of a more efficient, pure data switch exclusively for data communication purposes will be required.

This configuration is assumed to incorporate a modem pool. The more than 180 existing standalone modems using voice lines will be utilized initially, gradually being replaced by data lines.

FIGURE 5-3. DATA SWITCH (DS) ALTERNATIVE 1: CENTRALIZED STAR

WITHIN CLUSTERS													BETWEEN CLUSTERS				
OVERALL CONFIG	TOPOLOGY				SWITCHING				MEDIA				TOPOLOGY	SWITCHING	MEDIA		
	CT	W	PC	M	CT	W	PC	M	CT	W	PC	M			CT	W	PC	M
1.0 C	MD (&) S	S	S	S	N (&) Y	N	Y	N (&) Y	STP2 (&) TP	C2	TP	TP	1.0 S	1.0 C	STP2 (&) TP	C2 (&) TP	TP	TP

CENTRAL NODES AND EXTERNAL GATEWAYS	MAJOR ASSUMPTIONS / NOTES
O VIA COMMUNICATION SERVERS TO PACKET SWITCHED, PUBLIC AND LEASED NETWORKS O DATA SWITCH & SL-100 AS NETWORK CONTROL CENTER	O UP TO 400 DATA LINES BY 1987-88, 1000 BY 1990 AND OVER 1500 BY 1993-94. O CONTINUED USE OF 100+ INDIVIDUAL MODEMS. O WILL GROW INTO A HI-SPEED DATA SWITCHED NETWORK BY 1990'S WITH A MODEM POOL. O STANDARD TERMINALS USE DATA LINES FOR SWITCHED CONNECTIONS, DIRECTLY OR VIA HOST/CONTROLLERS. O ALL WANG TERMINALS CONNECTED TO DATA SWITCH VIA THEIR HOST/CONTROLLERS, ONLY. O WANG HOSTS/CONTROLLERS HAVE MULTIPLE COMMUNICATION PORTS CONNECTED TOGETHER USING WANGNET. O PC's USE DATA LINES FOR ALL INTERCONNECTIONS. O TERMINALS ON MINIS (DEC, HARRIS AND PRIME) USE DATA LINES FOR SWITCHED CONNECTIONS, DIRECTLY OR VIA THEIR HOST/CONTROLLER. O TERMINALS TO MINIS WILL MIGRATE FROM 100% HARDWARE TO 80% DATA LINE CONNECTIONS.

SYMBOLS LEGEND

1. & - BUS
2. C - CENTRAL
3. CT - CONVERGENT TECHNOLOGY
4. C1 - ONE COAXIAL CABLE (ETHERNET
5. C2 - TWO COAXIAL CABLE
6. D - DISTRIBUTED
7. M - MINI
8. MD - MULTI DROP
9. N - NO
10. NIU - NETWORK UNIT INFERFACE
11. NCC - NETWORK CONTROL CENTER
12. PC - PERSONAL COMPUTER
13. S - STAR
14. STP2 - TWO SHIELDED TWISTED PAIR
15. T - TREE
16. TP - TWISTED PAIR
17. W - WANG
18. Y - YES

FIGURE 5-4. DATA LINE DISTRIBUTION ASSUMPTIONS/PROJECTIONS FOR ALTERNATIVE 1 DATA SWITCH (DS)

DATA EQUIPMENT		PERIOD		
VENDOR	TYPE	1986-88	1990	1993-94
STANDARD TERMINAL	HOST/ CONTROLLERS	20 (20%)	100 (100%)	100 (100%)
	WORKSTATION	200 (20%)	630 (60%)	950 (90%)
WANG	HOST/ CONTROLLERS	30 (100%; 3/HOST)	30 (100%; 3/HOST)	30 (100%; 3/HOST)
	WORKSTATION	0	0	0
MINIS o PRIME o DEC o HARRIS	HOST/ CONTROLLERS	30 (100%;4/HOST)	40 (100%; 7/HOST)	70 (100%; 10/HOST)
	WORKSTATION	70 (30%)	90 (35%)	160 (65%)
PERSONAL COMPUTERS	WORKSTATION	50 (30%)	110 (45%)	230 (90%)
ASSUMPTIONS/ NOTES		o 400 DATA LINES REPLACE HARD WIRED AS MOVED/ ACCESSIBILITY TO MULTIPLE MINIS REQUIRED.	o 1000 DATA LINES INSTALLATION OF DATA SWITCH ENHANCEMENT	o 1500+ DATA LINES o MINIMAL USE OF STAND ALONE MODEMS

* IN ADDITION TO USE OF APPROXIMATELY 180 EXISTING MODEMS USING VOICE LINES.

NUMBERS ROUNDED TO NEAREST TEN

The Standard Terminal workstations will use modems or data lines for switched connections either directly or via their host/controllers.

All Wang workstations will be connected to the data switch through their host/controllers (VS-100s) using modems or data lines. They will continue to be connected to their host/controllers via high speed dual coaxial cable. Wang host/controllers will continue to be interconnected via Wang-Net, and they will also connect to the SL-100 PBX via modems and NIUs. The personal computers will use modems or data lines for all communications. The workstations connected to other minicomputers at Headquarters (i.e., Digital Equipment Corporation VAX 11/750, Harris 800, PRIME 750 and Wang) will use data lines or modems for switched connections, either directly or via their host/controllers. The workstation connections to minicomputers will migrate from connections which are now 100% hard-wired to 65% using data communication lines.

The Data Switch alternative employs a central switching logic that utilizes standard telephone twisted pair wiring radiating outward from a central point (star). It accommodates 100% of the workstation data switching requirements, either directly or through host controllers.

This alternative has the advantage of intially utilizing existing, paid-for equipment (SL-100), including wiring and the equivalent of a network control center. However, any centralized switching and routing system is vulnerable to total loss of its capabilities when the switch fails. It also presents potential traffic handling constraints as the number of data users increases.

5.7.1.3 Block Diagrams

Figure 5-5 illustrates, in simplified form, the Data Switch LAN across the Transport Building's six floors utilizing four wiring closets per floor. Figure 5-6 portrays sector illustrations of this alternative for the first and sixth floors of the Transpoint Building.

5.7.1.4 Standards

The Data Switch alternative, which is composed of a mix of devices (workstations and host/controllers), will utilize a mix of connections for data communications. This alternative incorporates physical connections:

1) twisted pair wiring based data connections such as RS-449 between:

a. devices using a network interface unit (NIU) and the SL-100 PBX, and

b. those workstations within the Standard Terminal clusters;

2) RS-232 connections when voice lines and modems are utilized; and

3) standard and vendor proprietary data linkage protocols such as RS-422 and others between directly wired workstations and their respective host/controllers (i.e. Standard Terminals, PRIME, Harris, and DEC).

By 1990, when the number of workstations is projected to be 1,000, the data switching capability of this alternative will be upgraded to handle the 250% increase in data lines. The number of devices utilizing minicomputer vendor proprietary protocols will decrease. By 1993 it is projected that the majority (approximately 75%) of all data communications within Headquarters will utilize standardized data linkage protocols provided by the data switch. The balance of devices will continue to utilize mini vendor proprietary protocols.

5.7.2 Baseband (bb) Conceptual Design 2: Distributed Bus

5.7.2.1 Overview

The Baseband alternative fulfills the system and user requirements by employing distributed switching in a bus topology for approximately 80% of the data communication requirements. The remaining 20% is handled by the SL-100 PBX. The topology, switching and electronic media used within and between clusters are detailed in Figure 5-7 for the Standard Terminal, Wang, Personal Computer and minicomputer workstations and host/controllers.

5.7.2.2 Assumptions and Description

The Baseband Alternative consists of a backbone coaxial cable that is installed throughout the Headquarters. The topological configuration is that of separate baseband networks connected to the backbone using baseband bridges and/or gateways. Access and connectivity by users is achieved using distributed switching inherent in the network.

The assumption made for the Baseband Alternative is that the predominant technology employed is Ethernet (IEEE 802.3). With the exception of the use of WangNet to interconnect Wang host/controllers, broadband technology is not employed.

FIGURE 5-5. BUILDING BLOCK DIAGRAM, CONCEPTUAL DESIGN 1: DATA SWITCH (DS)

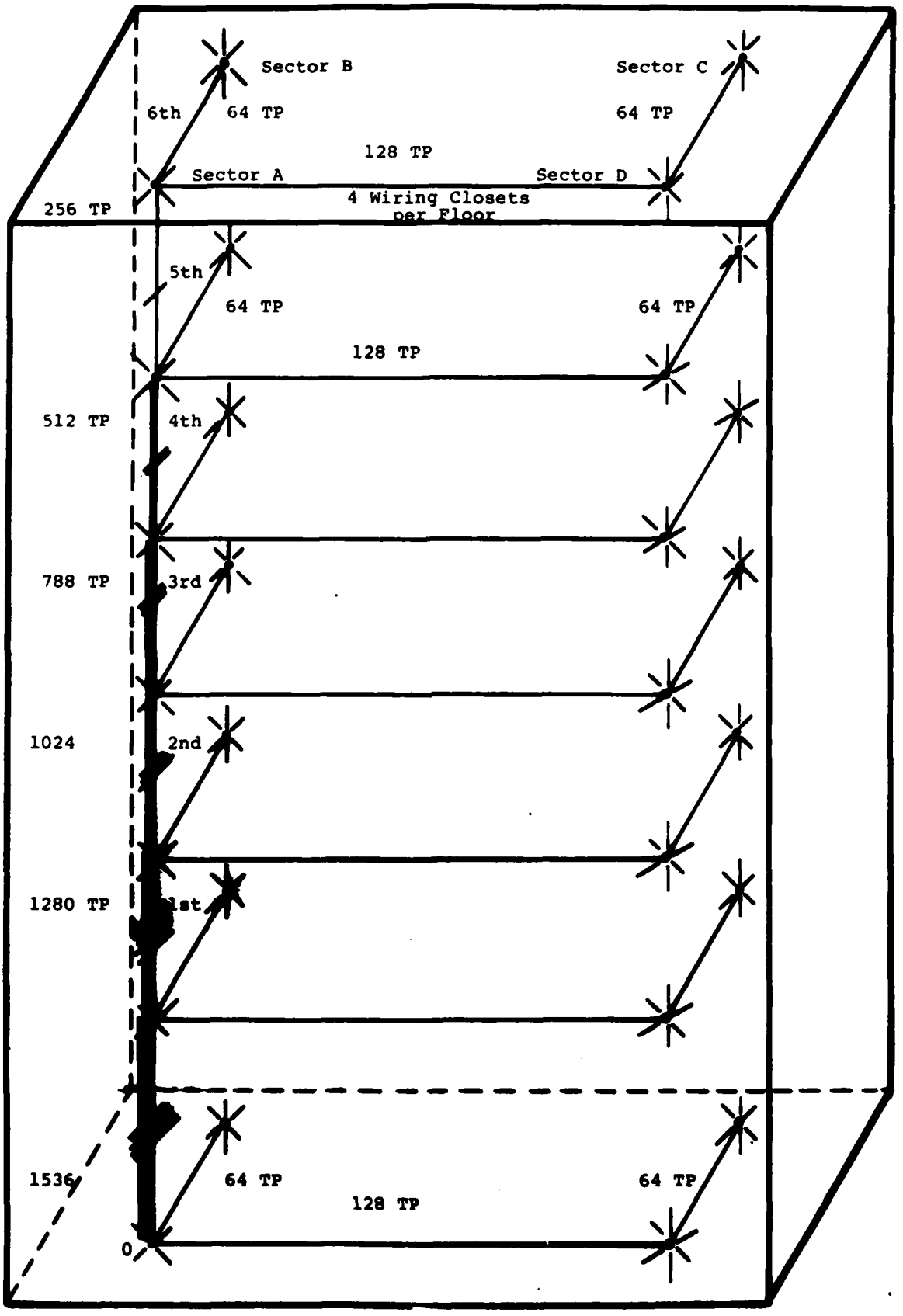
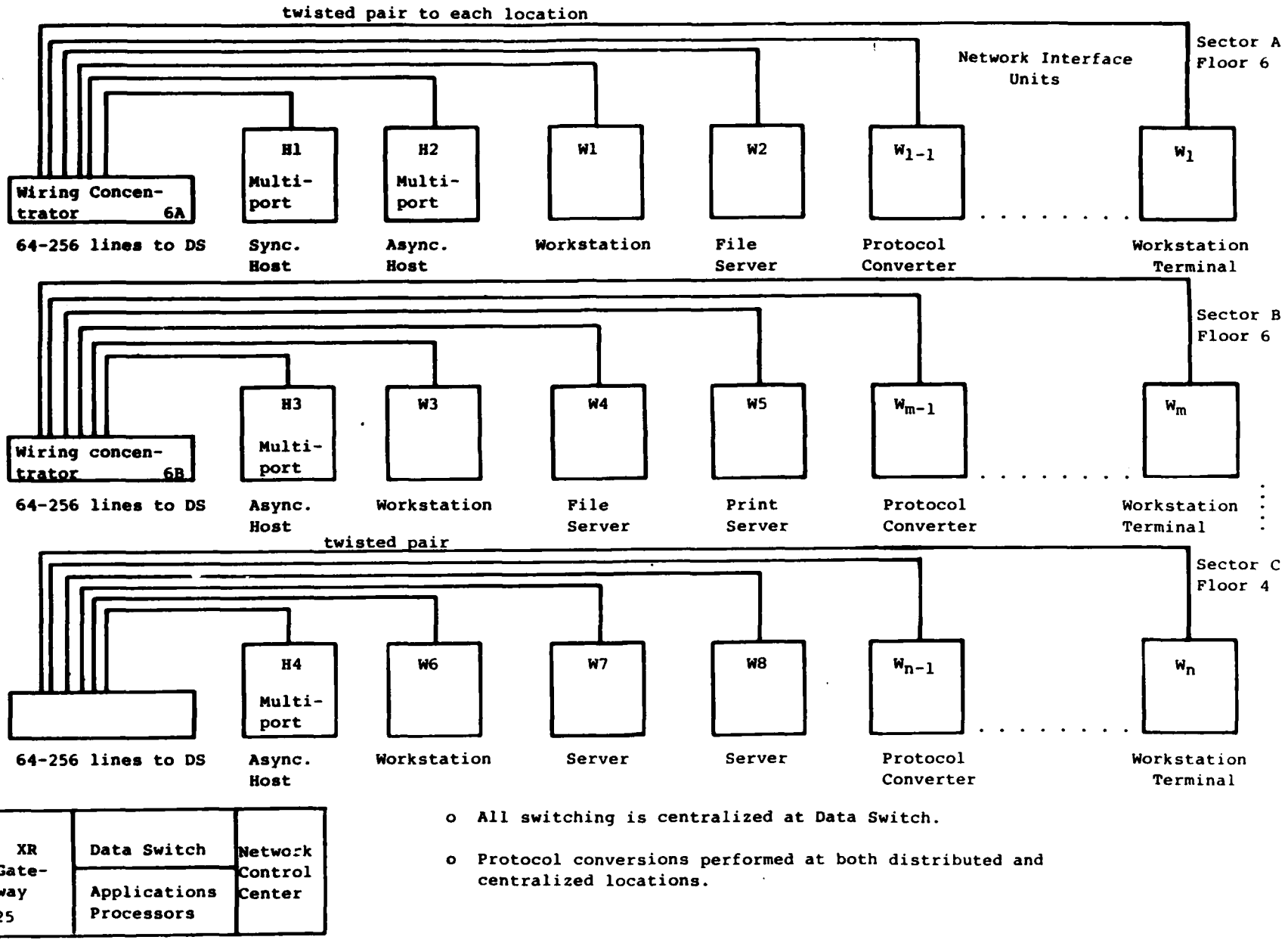


FIGURE 5-6. FLOOR BLOCK DIAGRAM, CONCEPTUAL DESIGN 1: DATA SWITCH (DS)



- All switching is centralized at Data Switch.
- Protocol conversions performed at both distributed and centralized locations.

FIGURE 5-7. BASEBAND (bb) ALTERNATIVE 2: DISTRIBUTED BUS

WITHIN CLUSTERS												BETWEEN CLUSTERS					
OVERALL CONFIG	TOPOLOGY				SWITCHING				MEDIA				TOPOLOGY	SWITCHING	MEDIA			
	CT	W	PC	M	CT	W	PC	M	CT	W	PC	M			CT	W	PC	M
0.8 D	MD (&) B	S	B	B	0.8 D				STP2 (&) C1	C2	C1	C1	0.8 D	0.8 D	C1	C2	C1	C1
0.2 C	S	--	S	S	0.2 C				TP	--	TP	TP	0.2 S	0.2 C	TP	TP	TP	TP

CENTRAL NODES AND EXTERNAL GATEWAYS	MAJOR ASSUMPTIONS / NOTES
O VIA COMMUNICATIONS SERVERS TO PACKNET SWITCHED, PUBLIC AND LEASED NETWORKS. O DATA SWITCH NODE. O BASEBAND NETWORK CONTROL CENTER NODE.	O INCLUDES ALL DATA SWITCH ASSUMPTIONS IN ALTERNATIVE 1 TO 1987-88 (400 DATA LINES), PLUS: O BACKBONE HIGH SPEED COMMUNICATIONS USE ETHERNET BASEBAND TECHNOLOGY. O USE OF BROADBAND TECHNOLOGY (WANGNET) FOR WANG HOST/CONTROLLERS. O WANG HOST/CONTROLLERS ARE CONNECTED TO EACH OTHER VIA THE DATA SWITCH OR DIRECTLY USING COAXIAL CABLE. O STANDARD TERMINALS OPERATE ON ETHERNET. O STANDARD TERMINALS USE EXISTING SHIELDED TWISTED PAIR BASEBAND OR ETHERNET FOR INTERCONNECTION. O MINIS ARE CONNECTED TO EACH OTHER DIRECTLY VIA ETHERNET OR VIA THE DATA SWITCH. THEIR TERMINALS ARE CONNECTED TO THE MINI VIA ETHERNET BASEBAND OR VIA THE DATA SWITCH. O PC'S ARE INTERCONNECTED VIA ETHERNET BASEBAND.

SYMBOLS LEGEND

1. B - BUS
2. C - CENTRAL
3. CT - CONVERGENT TECHNOLOGY
4. C1 - ONE COAXIAL CABLE (ETHERNET)
5. C2 - TWO COAXIAL CABLE
6. D - DISTRIBUTED
7. M - MINI
8. MD - MULTI DROP
9. N - NO
10. NIU - NETWORK UNIT INTERFACE
11. NCC - NETWORK CONTROL CENTER
12. PC - PERSONAL COMPUTER
13. S - STAR
14. STP2 - TWO SHIELDED TWISTED PAIR
15. T - TREE
16. TP - TWISTED PAIR
17. W - WANG
18. Y - YES

The Standard Terminal workstations and host/controllers will operate using Ethernet and the SL-100 switch. The workstations will be connected using either the existing shielded twisted pair wiring or, alternatively, via Ethernet on coaxial cable. The host/controllers will be interconnected using an Etherent coaxial cable baseband system.

Some of the Standard Terminal workstations will be connected to the data switch via modems/data modules using twisted pair wiring. They will initially be connected to each other within clusters using either existing shielded pair wiring or Ethernet coaxial cable; these connections are projected to migrate over the 1990-93 timeframe to be 100% Ethernet based.

Minicomputers are interconnected via an Ethernet-based coaxial cable subsystem or through the SL-100 switch. Workstations attached to minicomputers are also connected to their host via an Ethernet based coaxial cable or the SL-100 data switch. All personal computers in this alternative are interconnected via Ethernet.

The Wang devices are expected to continue to maintain the present WangNet (broadband) connections between host/controllers and direct (dual coaxial cable) connections between workstations and host/controllers. The Wang VS-100 will be connected to the PBX via modems and NIUs using twisted pair wiring.

5.7.2.3 Block Diagrams

Figure 5-8 illustrates, in simplified form, the baseband LAN across the Transpoint Building's six floors. Figure 5-9 provides illustrations of several types of NIU devices and their topological interconnection possibilities.

5.7.2.4 Standards

The Baseband Alternative, in addition to including up to 400 data devices utilizing data modules with the SL-100 switch, will initially include 100-200 users communicating via the SL-100 PBX using voice lines over low speed modems. Protocol and standards issues discussed in Alternative #1 will continue to apply to approximately 20% of the users for Alternative #2. Data switch users in this alternative are projected to be distributed as shown for the 1986-88 period in the Data Switch (Alternative #1) conceptual design.

The devices that are not directly connected to the PBX in this alternative, with the exception of Wang workstations and host/controllers, are connected via an Ethernet (IEEE 802.3 10 Mb/s) baseband system. This will include most of the Standard Terminal workstations and host/controllers and

FIGURE 5-8. BUILDING BLOCK DIAGRAM, CONCEPTUAL DESIGN 2: BASEBAND (bb)

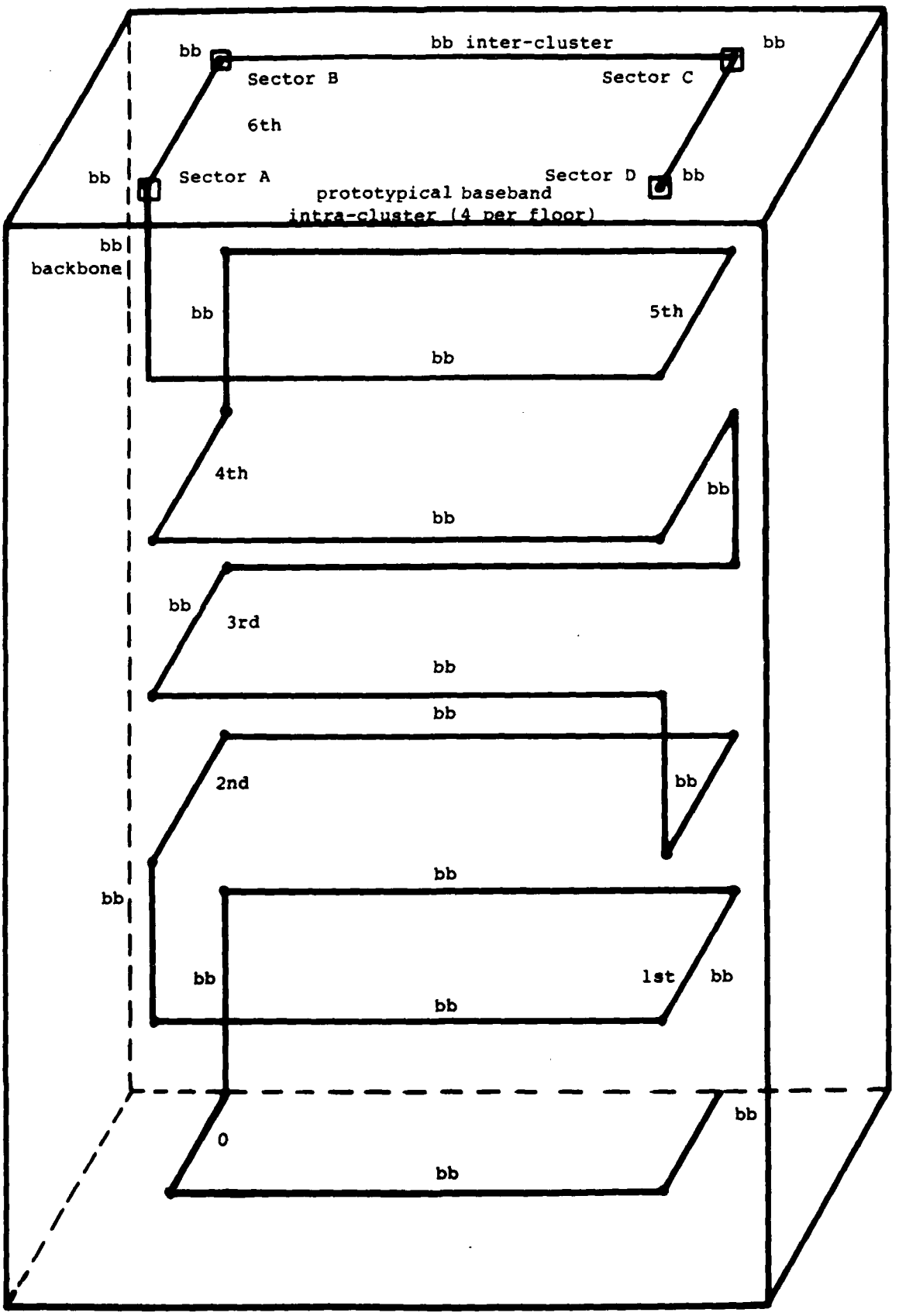
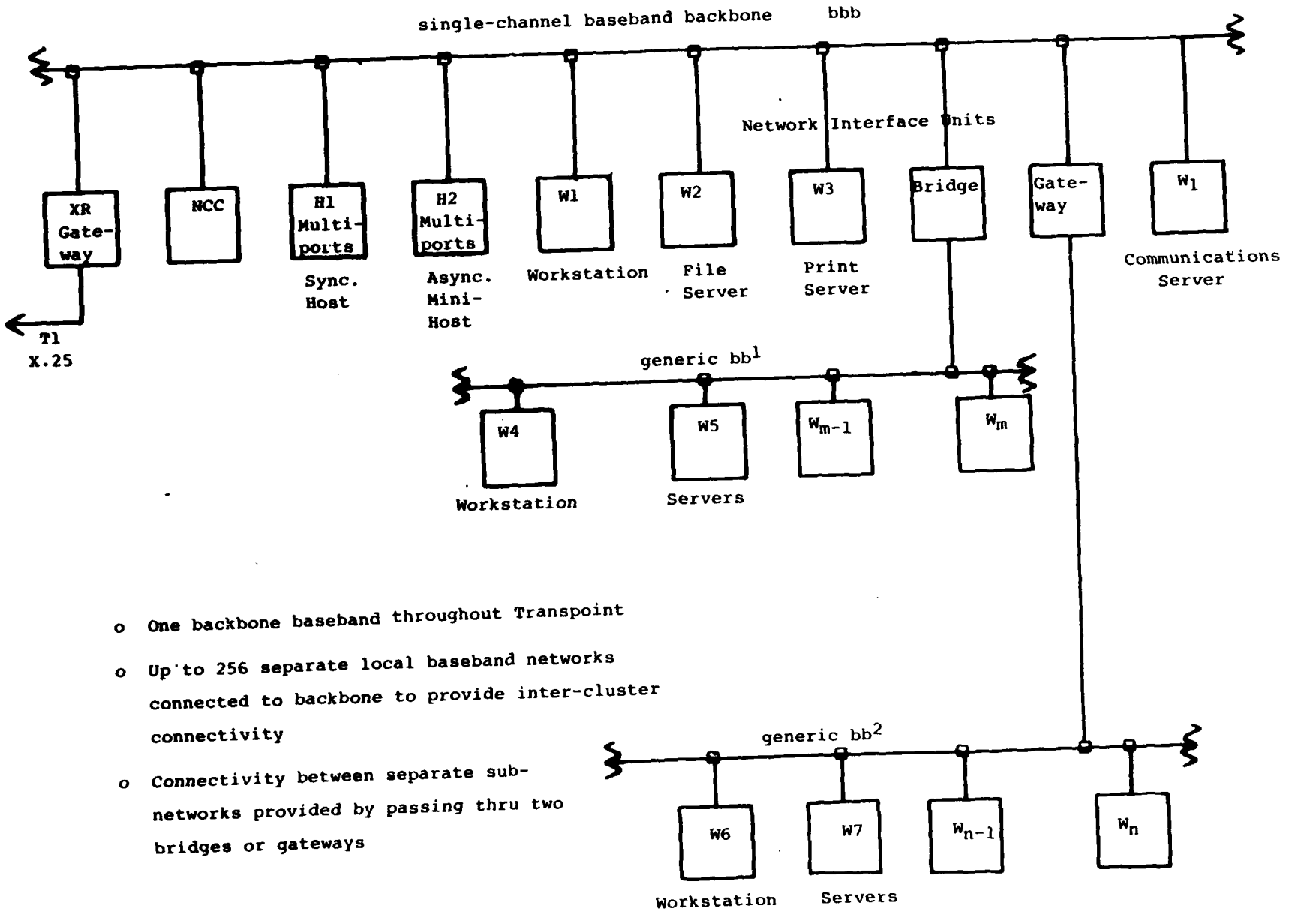


FIGURE 5-9. FLOOR BLOCK DIAGRAM, CONCEPTUAL DESIGN 2: BASEBAND (bb)



- o One backbone baseband throughout Transpoint
- o Up to 256 separate local baseband networks connected to backbone to provide inter-cluster connectivity
- o Connectivity between separate sub-networks provided by passing thru two bridges or gateways

all of the PRIME, Harris, and DEC minicomputers and their attached devices, in addition to the personal computers. The Baseband network will incorporate a number of bridges between buses and gateways to the SL-100 data PBX.

5.7.3 Broadband (BB) Conceptual Design 3: Distributed Tree

5.7.3.1 Overview

The Broadband Alternative fulfills the system and user requirements by employing distributed switching in a tree topology (See Figure 5-10) for 80% of the requirements. The remaining 20% is handled by the SL-100 PBX. The topology, switching and electronic media used within and between clusters are detailed in this figure for the Standard Terminal, Wang, personal computer and minicomputer workstations and host/controllers.

5.7.3.2 Assumptions and Description

The Broadband Alternative consists of a dual coaxial cable WangNet that is installed througout the Headquarters. The assumptions made for the Broadband Alternative are that the technology is WangNet (broadband) throughout. All workstations and host/controllers will migrate to a dual cable broadband medium (WangNet) except for approximately 20% (400) of the devices that will use the SL-100 switch.

This Broadband Alternative has the advantage of utilizing WangNet, which is compatible with the large existing Wang equipment population (25%) of the USCG Headquarters.

5.7.3.3 Block Diagrams

Figure 5-11 illustrates, in simplified form, the Broadband LAN across the six floors of the Transport Building. Figure 5-12 portrays several types of the backbone network as well as showing the rather simplified topology of a pure branched try network.

5.7.3.4 Standards

The Broadband Alternative incorporates a dual coaxial cable WangNet architecture. With the exception of the devices projected to initially use the SL-100 for data communications (approximately 20%), all host/controllers and workstations are interconnected using a frequency multiplexed broadband (i.e., WangNet) system. The twisted pair data communications and linkages previously discussed for Alternative #1 will apply to 20% of this Alternative.

FIGURE 5-10. BROADBAND (BB) ALTERNATIVE 3: DISTRIBUTED TREE

WITHIN CLUSTERS													BETWEEN CLUSTERS					
OVERALL CONFIG	TOPOLOGY				SWITCHING				MEDIA				TOPOLOGY	SWITCHING	MEDIA			
	CT	W	PC	M	CT	W	PC	M	CT	W	PC	M			CT	W	PC	M
0.8 D	T	T	T	T	0.8 D				C2	C2	C2	C2	0.8 T	0.8 D	C2	C2	C2	C2
0.2 C	S	--	S	S	0.2 C				TP	--	TP	TP	0.2 S	0.2 C	TP	TP	TP	TP

CENTRAL NODES AND EXTERNAL GATEWAYS	MAJOR ASSUMPTIONS / NOTES
O VIA COMMUNICATION SERVERS TO PACKNET SWITCHED, PUBLIC AND LEASED NETWORKS. O DATA SWITCH NODE. O BROADBAND NETWORK HEADEND. O BROADBAND NETWORK CONTROL CENTRAL NODE.	O INCLUDES ALL DATA SWITCH ASSUMPTIONS IN ALTERNATIVE 1 TO 1987-88 (400 DATA LINES), PLUS: O USES BROADBAND THROUGHOUT. O ALL WORKSTATIONS AND HOST/CONTROLLERS ARE ON A 2 CABLE BROADBAND MEDIA EXCEPT FOR UP TO 20% OF NODES (400) THAT USE DATA SWITCH DATA LINES.

SYMBOLS LEGEND

1. B - BUS
2. C - CENTRAL
3. CT - CONVERGENT TECHNOLOGY
4. C1 - ONE COAXIAL CABLE (ETHERNET)
5. C2 - TWO COAXIAL CABLE
6. D - DISTRIBUTED
7. M - MINI
8. MD - MULTI DROP
9. N - NO
10. NIU - NETWORK UNIT INTERFACE
11. NCC - NETWORK CONTROL CENTER
12. PC - PERSONAL COMPUTER
13. S - STAR
14. STP2 - TWO SHIELDED TWISTED PAIR
15. T - TREE
16. TP - TWISTED PAIR
17. W - WANG
18. Y - YES

FIGURE 5-11. BUILDING BLOCK DIAGRAM CONCEPTUAL DESIGN 3: BROADBAND (BB)

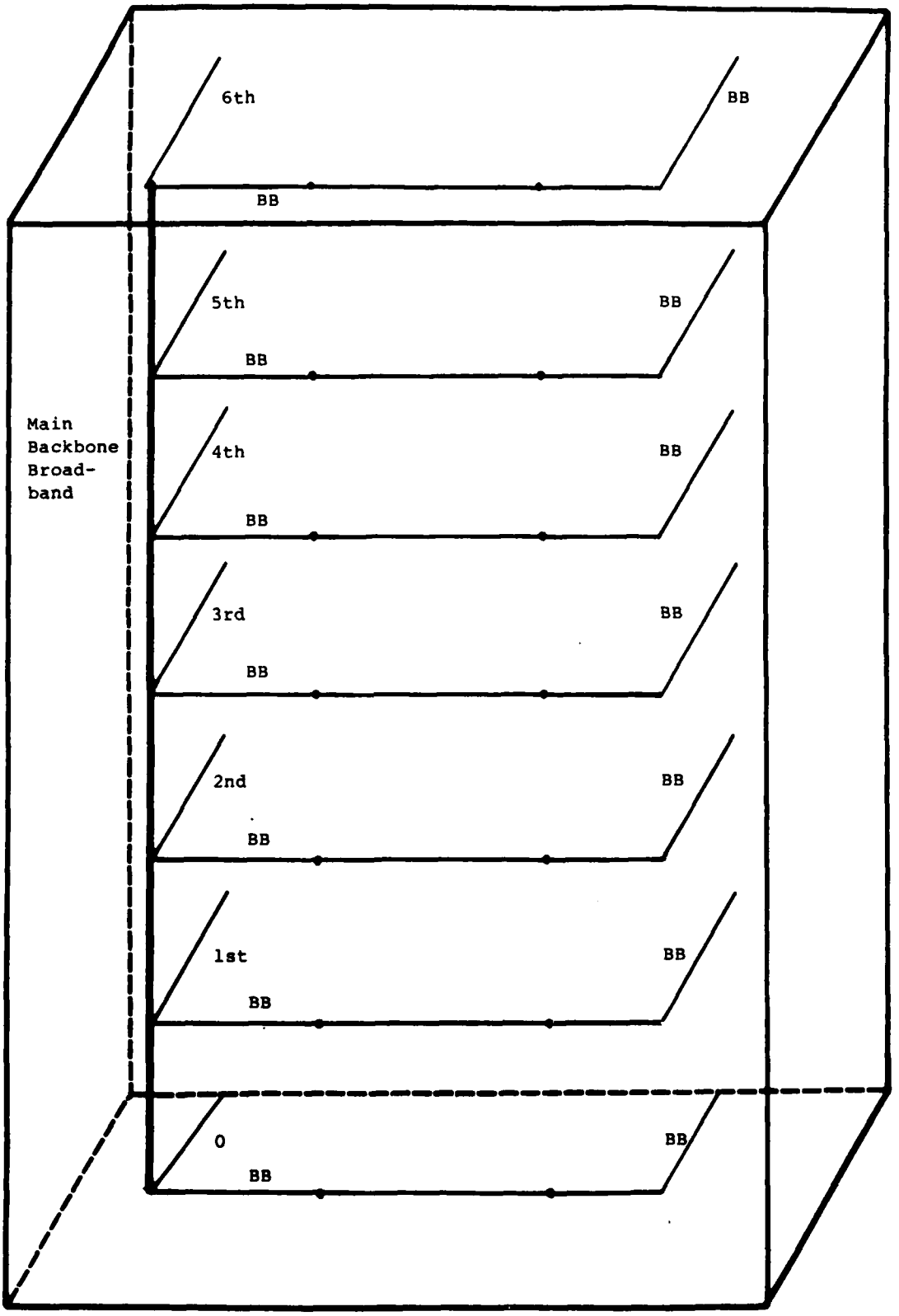
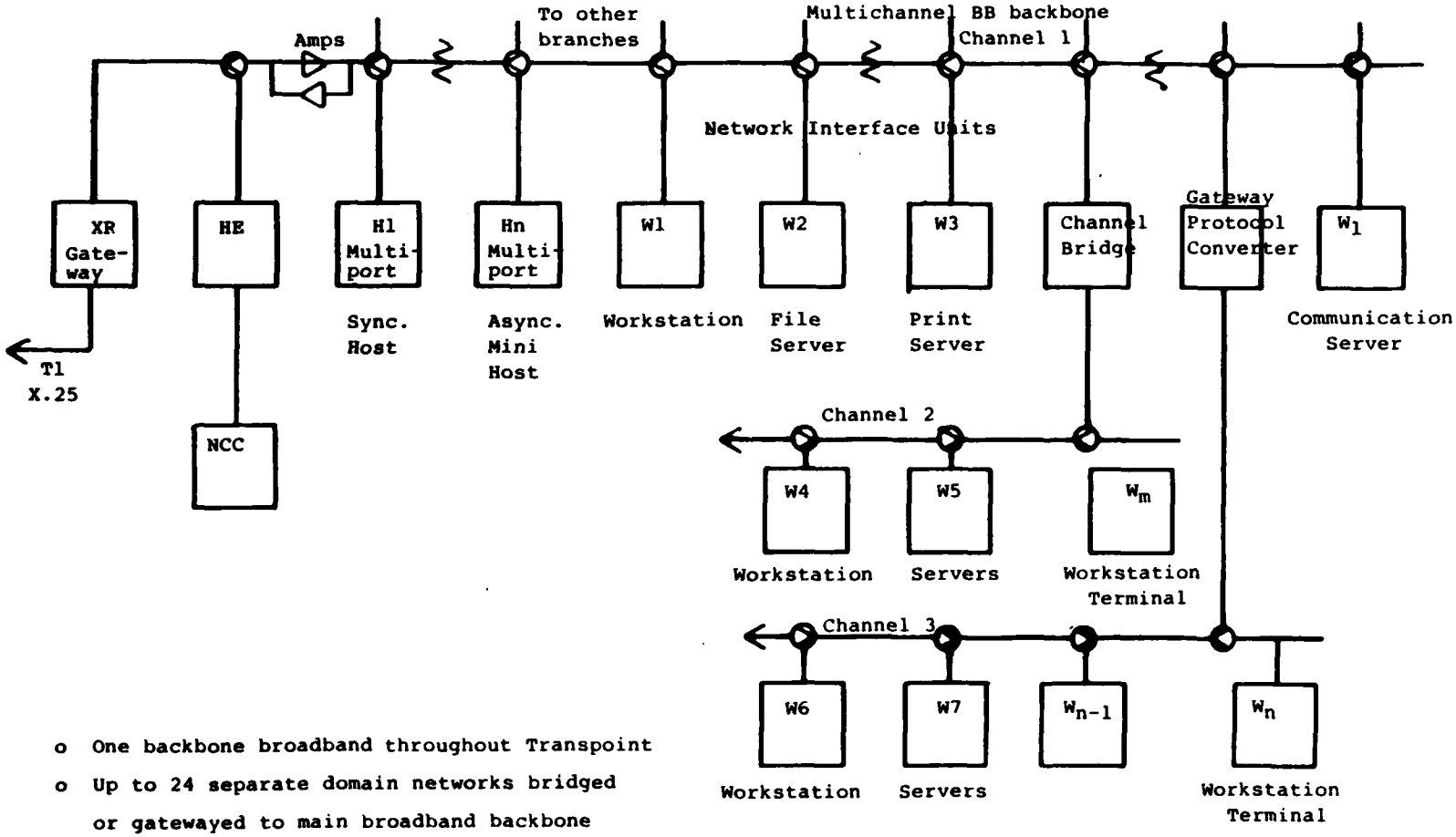


FIGURE 5-12. FLOOR BLOCK DIAGRAM, CONCEPTUAL DESIGN 3: BROADBAND (BB)



- o One backbone broadband throughout Transpoint
- o Up to 24 separate domain networks bridged or gatewayed to main broadband backbone (may be separate channels or the single physical cable plant)
- o Two-way broadband is provided by dual-cable

The Broadband Alternative incorporates bridges between different broadband segments and gateways to the SL-100 data PBX and the external networks previously described.

5.7.4 Hybrid (Bb) Conceptual Design 4: Distributed Tree/Bus

5.7.4.1 Overview

The Hybrid Alternative fulfills the system and user requirements by employing distributed switching in a combined broadband tree and baseband/broadband bus topology (see Figure 5-13) for 80% of the requirements. The remaining 20% is handled by the SL-100 PBX. As in the previous alternatives, the topology, switching and electronics media used within and between clusters are detailed in this figure for the Standard Terminal, Wang, personal computer and minicomputer workstations and host/controllers.

5.7.4.2 Assumptions and Description

The assumptions made for the Hybrid Alternative are that the LAN backbone uses broadband (WangNet) technology; the workstations and host/controllers use a mix of baseband (Ethernet) and broadband (WangNet) technology within clusters, except for approximately 20% (400) of the devices that initially use the data switch for data communications.

The Hybrid Alternative consists of a broadband (WangNet) backbone and multiple baseband (Ethernet) buses throughout the Headquarters.

The Hybrid Alternative combines aspects of all of the first three alternatives. It also includes approximately 20% of the devices using the data switch PBX for data communications. Within workstation clusters, the Hybrid Alternative provides for a mix of Ethernet baseband and WangNet broadband architectures. The backbone architecture that interconnects all host/controllers is a WangNet broadband.

This Alternative has the advantage of utilizing WangNet, which is compatible with the large Wang equipment population (25%) in the Transpoint Building. In addition, the heavy use of the popular Ethernet standard baseband technology reduces the impact of inter-device incompatibilities.

5.7.4.3 Block Diagrams

Figure 5-14 illustrates, in simplified form, the Hybrid LAN across the Transpoint Building. Figure 5-15 portrays a portion of a typical sector subnetwork and how it might be interconnected through bridges and gateways.

FIGURE 5-13. HYBRID (Bb) ALTERNATIVE 4: DISTRIBUTED TREE/BUS

WITHIN CLUSTERS													BETWEEN CLUSTERS				
OVERALL CONFIG	TOPOLOGY				SWITCHING				MEDIA				TOPOLOGY	SWITCHING	MEDIA		
	CT	W	PC	M	CT	W	PC	M	CT	W	PC	M			CT	W	PC	M
0.8 D	MD	T	B	B	0.8 D				STP2	C2	C1	C1	0.8 T	0.8 D	C2	C2	C2	C2
	(&)		(&)	(&)					(&)		(&)	(&)						
	T		T	T					C1		C2	C2						
									(&)									
									C2									
0.2 C	S	--	S	S	0.2 C				TP	--	TP	TP	0.2 S	0.2 C	TP	TP	TP	TP

CENTRAL NODES AND EXTERNAL GATEWAYS	MAJOR ASSUMPTIONS / NOTES
O VIA COMMUNICATION SERVERS TO PACKNET SWITCHED, PUBLIC AND LEASED NETWORKS.	O INCLUDES ALL DATA SWITCH ASSUMPTIONS IN ALTERNATIVE 1 TO 1987-88 (400 DATA LINES), PLUS.
O DATA SWITCH NODE.	O BACKBONE HIGH SPEED CONNECTIONS ARE VIA BROADBAND TECHNOLOGY.
O BROADBAND NETWORK HEADEND.	
O BROADBAND NETWORK CONTROL CENTRAL NODE.	O WORK STATIONS AND HOST/CONTROLLERS USE A MIX OF BASEBAND AND BROADBAND TECHNOLOGY WITHIN CLUSTERS.
	O UP TO 20% OF NODES (400) USE DATA SWITCH DATA LINES.

SYMBOLS LEGEND

1. B - BUS
2. C - CENTRAL
3. CT - CONVERGENT TECHNOLOGY
4. C1 - ONE COAXIAL CABLE (ETHERNET
5. C2 - TWO COAXIAL CABLE
6. D - DISTRIBUTED
7. M - MINI
8. MD - MULTI DROP
9. N - NO
10. NIU - NETWORK UNIT INFERFACE
11. NCC - NETWORK CONTROL CENTER
12. PC - PERSONAL COMPUTER
13. S - STAR
14. STP2 - TWO SHIELDED TWISTED PAIR
15. T - TREE
16. TP - TWISTED PAIR
17. W - WANG
18. Y - YES

FIGURE 5-14. BUILDING BLOCK DIAGRAM, CONCEPTUAL DESIGN 4: HYBRID (Bb)

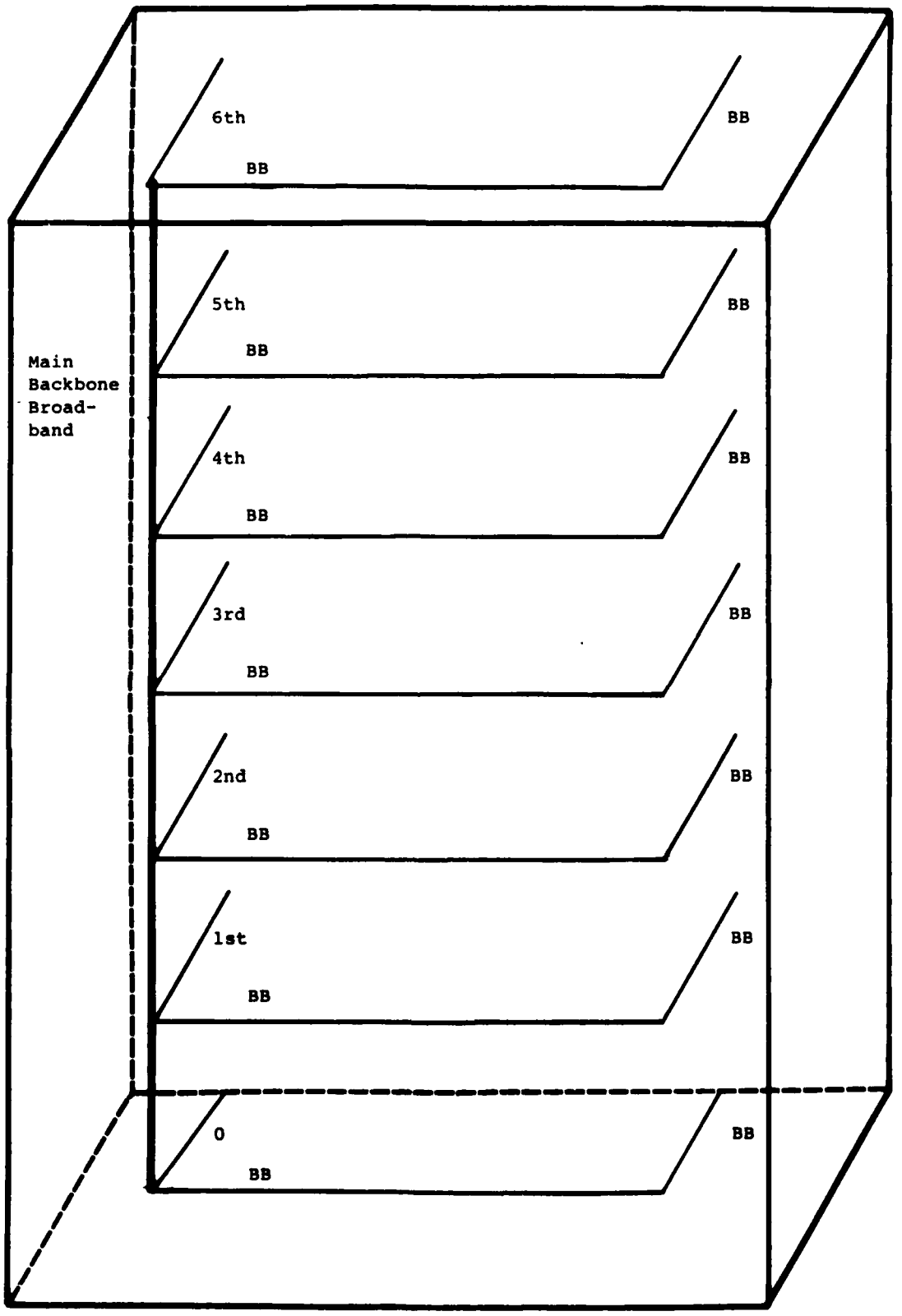
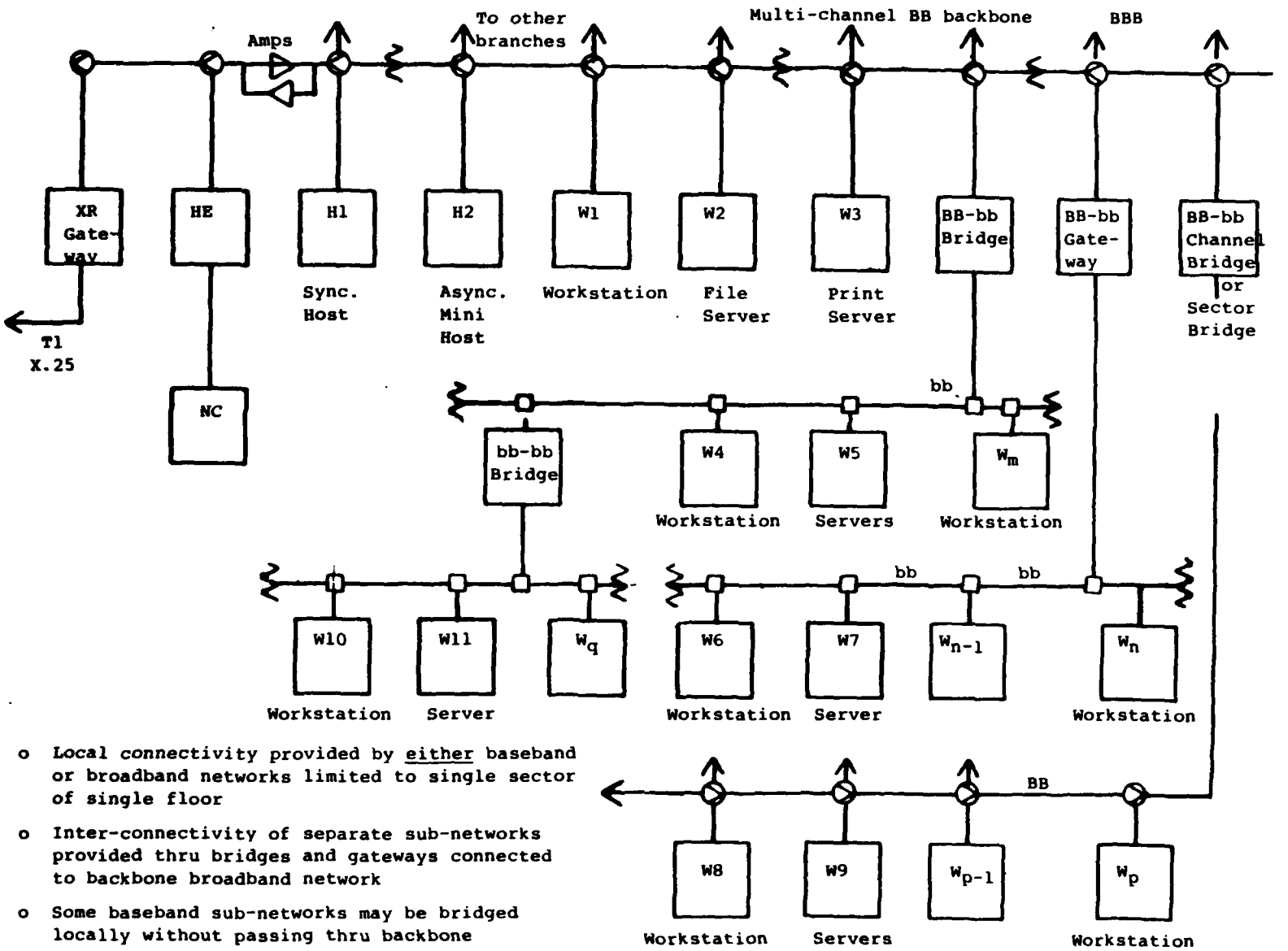


FIGURE 5-15. FLOOR BLOCK DIAGRAM, CONCEPTUAL DESIGN 4: HYBRID (Bb)



- Local connectivity provided by either baseband or broadband networks limited to single sector of single floor
- Inter-connectivity of separate sub-networks provided thru bridges and gateways connected to backbone broadband network
- Some baseband sub-networks may be bridged locally without passing thru backbone broadband network

5.7.4.4 Standards

Various bridges and gateways will interconnect the local Ethernet segments to the overall WangNet backbone. As in the Broadband Alternative (#3), the backbone for the Hybrid will have gateways to the PBX and to external networks, as previously described. In addition, all protocol issues previously addressed for the twisted pair wiring data communications apply to 20% of this Alternative.

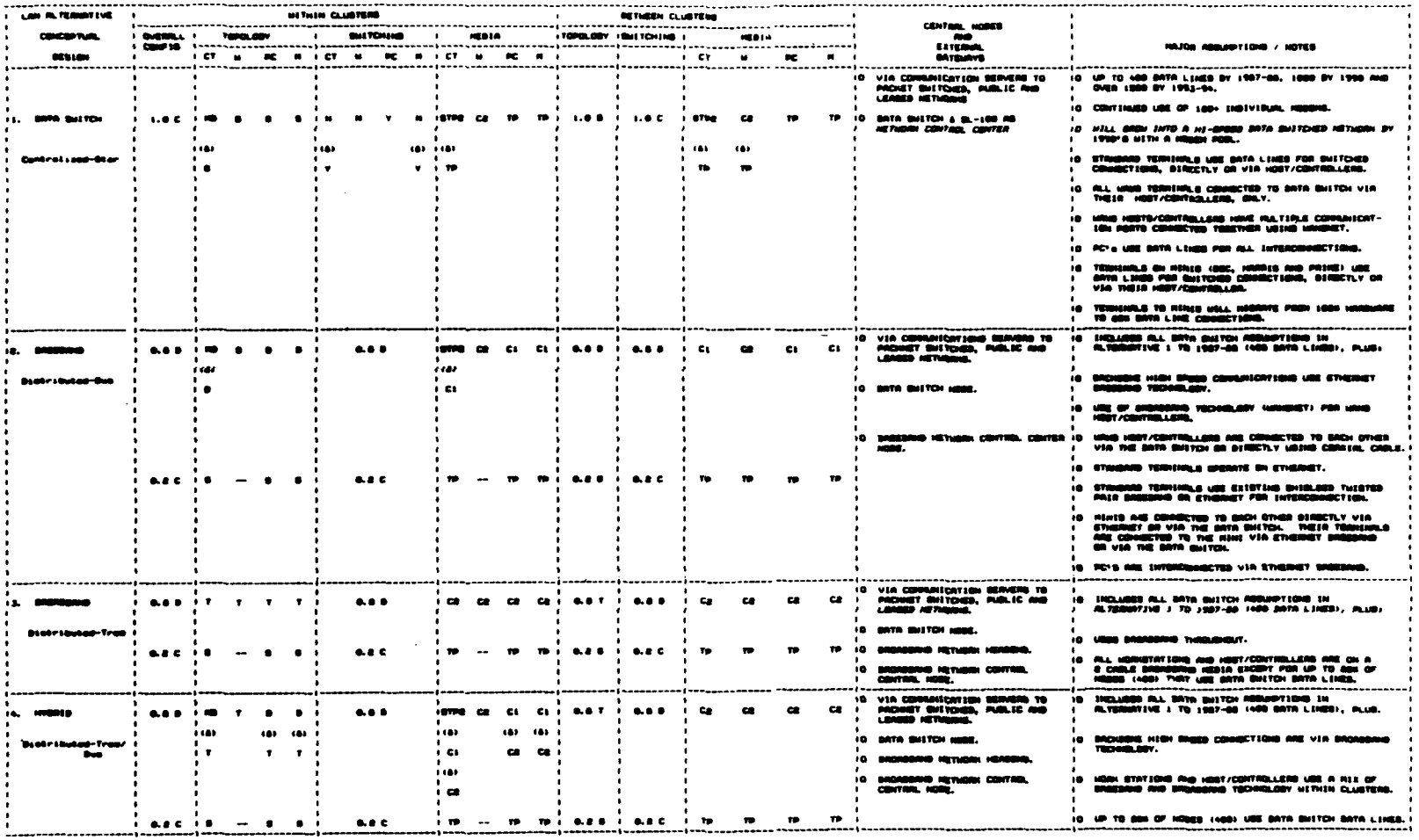
5.8 SUMMARY

This concludes the description and explanation of the four final alternative LAN conceptual designs chosen for further detailed examination and comparison. In this document, the methodology used to select the four conceptual designs is explained as a complex synthesis and analysis process. The equipment growth assumptions and projections are also detailed and described.

Each of the four alternative LAN conceptual designs (Data Switch, Baseband, Broadband, and Hybrid is discussed in detail to include individual descriptions, assumptions, block diagrams, and standards and discussions.

Figure 5-16 provides a summary of the information contained in this document regarding the four conceptual designs.

FIGURE 5-16. OVERVIEW OF ALTERNATIVE LAN CONCEPTUAL DESIGN



LAN ALTERNATIVE CONCEPTUAL DESIGN	WITHIN CLUSTERS: OVERALL CONFIG	WITHIN CLUSTERS: TOPOLOGY CT	TOPOLOGY M	TOPOLOGY PC	TOPOLOGY H	WITHIN CLUSTERS: SWITCHING CT	SWITCHING M	SWITCHING PC	SWITCHING H	WITHIN CLUSTERS: MEDIA CT	MEDIA M	MEDIA PC	MEDIA H	BETWEEN CLUSTERS: TOPOLOGY	BETWEEN CLUSTERS: SWITCHING	BETWEEN CLUSTERS: MEDIA CT	MEDIA M	MEDIA PC	MEDIA H	CENTRAL NODES AND EXTERNAL GATEWAYS	MAJOR ASSUMPTIONS / NOTES
1. DATA SWITCH	1.0 C	MD	S	S	S	N	N	Y	N	STP2	C2	TP	TP	1.0 S	1.0 C	STP2	C2	TP	TP	10 VIA COMMUNICATION SERVERS TO PACKET SWITCHED, PUBLIC AND LEASED NETWORKS 10 DATA SWITCH & SL-100 AS *NETWORK CONTROL CENTER*	10 UP TO 400 DATA LINES BY 1987-88, 1000 BY 1990 AND OVER 1500 BY 1993-94. 10 CONTINUED USE OF 100+ INDIVIDUAL MODEMS. 10 *WILL SOON MOVE INTO A HI-SPEED DATA SWITCHED NETWORK BY 1990'S WITH A HIGHER POOL.* 10 STANDARD TERMINALS USE DATA LINES FOR SWITCHED CONNECTIONS, DIRECTLY OR VIA HOST/CONTROLLERS. 10 ALL MINI TERMINALS CONNECTED TO DATA SWITCH VIA THEIR HOST/CONTROLLERS, ONLY. 10 MINI HOSTS/CONTROLLERS HAVE MULTIPLE COMMUNICATION PORTS CONNECTED TOGETHER USING MINISNET. 10 PC's USE DATA LINES FOR ALL INTERCONNECTIONS. 10 TERMINALS ON MINIS (DEC, HARRIS AND PRIME) USE DATA LINES FOR SWITCHED CONNECTIONS, DIRECTLY OR VIA THEIR HOST/CONTROLLER. 10 TERMINALS TO MINIS WILL MIGRATE FROM 100M HARDWARE TO 68M DATA LINE CONNECTIONS.
(1)		(1)				(1)			(1)	(1)						(1)	(1)				
Centralized-Star		S				Y			Y	TP						TP	TP				
2. BROADBAND	0.0 D	MD	S	S	S		0.0 D			STP2	C2	C1	C1	0.0 D	0.0 D	C1	C2	C1	C1	10 VIA COMMUNICATIONS SERVERS TO PACKET SWITCHED, PUBLIC AND LEASED NETWORKS. 10 DATA SWITCH NODE. 10 BROADBAND NETWORK CONTROL CENTER NODE.	10 INCLUDES ALL DATA SWITCH ASSUMPTIONS IN ALTERNATIVE 1 TO 1987-88 (400 DATA LINES), PLUS: 10 BROADBAND HIGH SPEED COMMUNICATIONS USE ETHERNET BROADBAND TECHNOLOGY. 10 USE OF BROADBAND TECHNOLOGY (MINISNET) FOR MINI HOST/CONTROLLERS. 10 MINI HOST/CONTROLLERS ARE CONNECTED TO EACH OTHER VIA THE DATA SWITCH OR DIRECTLY USING COAXIAL CABLE. 10 STANDARD TERMINALS OPERATE ON ETHERNET. 10 STANDARD TERMINALS USE EXISTING SHIELDED TWISTED PAIR BROADBAND OR ETHERNET FOR INTERCONNECTION. 10 MINIS ARE CONNECTED TO EACH OTHER DIRECTLY VIA ETHERNET OR VIA THE DATA SWITCH. THEIR TERMINALS ARE CONNECTED TO THE MINI VIA ETHERNET BROADBAND OR VIA THE DATA SWITCH. 10 PC'S ARE INTERCONNECTED VIA ETHERNET BROADBAND.
(1)		(1)								(1)											
Distributed-Bus		S								C1											
	0.2 C	S	—	S	S		0.2 C			TP	—	TP	TP	0.2 S	0.2 C	TP	TP	TP	TP		
3. BROADBAND	0.0 D	T	T	T	T		0.0 D			C2	C2	C2	C2	0.0 T	0.0 D	C2	C2	C2	C2	10 VIA COMMUNICATION SERVERS TO PACKET SWITCHED, PUBLIC AND LEASED NETWORKS. 10 DATA SWITCH NODE. 10 BROADBAND NETWORK HEADEND. 10 BROADBAND NETWORK CONTROL CENTER NODE.	10 INCLUDES ALL DATA SWITCH ASSUMPTIONS IN ALTERNATIVE 3 TO 1987-88 (400 DATA LINES), PLUS: 10 USES BROADBAND THROUGHOUT. 10 ALL WORKSTATIONS AND HOST/CONTROLLERS ARE ON A 2 CABLE BROADBAND MEDIA EXCEPT FOR UP TO 256 OF MODEMS (400) THAT USE DATA SWITCH DATA LINES.
Distributed-Tree																					
	0.2 C	S	—	S	S		0.2 C			TP	—	TP	TP	0.2 S	0.2 C	TP	TP	TP	TP		
4. HYBRID	0.0 D	MD	T	S	S		0.0 D			STP2	C2	C1	C1	0.0 T	0.0 D	C2	C2	C2	C2	10 VIA COMMUNICATION SERVERS TO PACKET SWITCHED, PUBLIC AND LEASED NETWORKS. 10 DATA SWITCH NODE. 10 BROADBAND NETWORK HEADEND. 10 BROADBAND NETWORK CONTROL CENTER NODE.	10 INCLUDES ALL DATA SWITCH ASSUMPTIONS IN ALTERNATIVE 1 TO 1987-88 (400 DATA LINES), PLUS: 10 BROADBAND HIGH SPEED CONNECTIONS ARE VIA BROADBAND TECHNOLOGY. 10 MINI STATIONS AND HOST/CONTROLLERS USE A MIX OF BROADBAND AND BROADBAND TECHNOLOGY WITHIN CLUSTERS.
(1)		(1)		(1)	(1)					(1)		(1)	(1)								
Distributed-Tree/Bus		T		T	T					C1		C2	C2								
										(1)											
										C2											
	0.2 C	S	—	S	S		0.2 C			TP	—	TP	TP	0.2 S	0.2 C	TP	TP	TP	TP	10 UP TO 256 OF NODES (400) USE DATA SWITCH DATA LINES.	

SYMBOLS LEGEND

1. D - DUO
2. C - CENTRAL
3. CT - CONVERGENT TECHNOLOGY
4. C1 - ONE COAXIAL CABLE (ETHERNET)
5. C2 - TWO COAXIAL CABLES
6. D - DISTRIBUTED
7. M - MINI
8. MD - MULTI DROP
9. N - NO
10. NIU - NETWORK UNIT INTERFACE
11. NCC - NETWORK CONTROL CENTER
12. PC - PERSONAL COMPUTER
13. S - STAR
14. STP2 - TWO SHIELDED TWISTED PAIR
15. T - TREE
16. TP - TWISTED PAIR
17. M - MINI
18. Y - YES

CHAPTER 6. ANALYSIS AND RESULTS

6.1 INTRODUCTION

This chapter presents the results of the technical and implementation evaluation analyses performed on each of the four LAN alternative conceptual designs prepared for Headquarters.

6.1.1 Evaluation Model

The four LAN alternatives were evaluated for each of the elements in the technical and implementation criteria sets contained in Appendix C.

The technical and implementation evaluation included a total of 29 elements. Each criterion was previously assigned a maximum weight by the Working Group which totaled 100 in each criteria class. In most cases weights were assigned during public discussion among Working Group members. The weights shown represent averages of many individual assessments. Each criteria class was assigned a maximum weight which totaled 100 in each set. The technical set was assigned a value of 80 and the implementation set 20. Thus, it was possible to compute ratings by element, class and set. Figure 6-1 summarizes the elements and weights used in the evaluation.

6.1.2 Growth Model

For each alternative, a growth schedule was established. A set of common assumptions was applied across all alternatives. These include:

- LAN installation will begin in fiscal 1988.
- The LAN installation will occur over a four year period.
- Rate of growth is dependent on LAN installed.
- Each LAN alternative includes a common baseline of 400 data ports on the Northern Telecom SL-100 PBX in a mix of low (under 9600 bps) and medium (between 9600 bps and 64,000 bps) speed lines.
- For approximately every two data ports allocated for workstations, another data port is reserved for a host/controller, modem pool, gateway, bridge or other support type attachment to the data switch.

FIGURE 6-1 LAN CRITERIA ELEMENTS AND ASSIGNED WEIGHTS

CRITERIA SET	CRITERIA CLASS	CRITERIA ELEMENT	ELEMENT WT. VALUE	CLASS WT. VALUE	SET WT. VALUE
1. TECHNICAL	a. HEADQUARTERS COMPATIBILITY	HEADQUARTERS POLICIES AND GOALS	10	25	80
		EXISTING OPERATIONAL PROCEDURES	15		
		EXISTING HARDWARE	30		
		EXISTING COMMUNICATIONS SOFTWARE AND PROTOCOLS	25		
		EXISTING AND PLANNED HEADQUARTERS PHYSICAL FACILITIES	10		
		AVAILABLE PERSONNEL/ SUPPORT RESOURCES	10		
		-------- SUM --------	100		
	b. NETWORK SYSTEM PERFORMANCE	AVAILABILITY/ RELIABILITY	20	30	
		CONNECTIVITY/ CONCURRENCY	20		
		TRAFFIC-CARRYING CAPACITY	10		
		TRANSMISSION SPEED/ RESPONSE TIME	10		
		ERROR RATES	05		
		MEASUREMENT AND CONTROL CAPABILITY	10		
		SECURITY LEVELS ACHIEVABLE	15		
		FAULT CORRECTION FACILITY	10		
		-------- SUM --------	100		
	c. EASE OF USE	REQUIRED TRAINING	20	20	
		DAILY OPERATIONS	25		
		QUALITY OF DOCUMENTATION	20		
		ONGOING MAINTENANCE	10		
		CONTROL, MANAGEMENT, AND CONFIGURATION CAPABILITIES	25		
		-------- SUM --------	100		
	d. GROWTH CAPACITY	ACCOMODATION TO MOVES AND CHANGES	40	25	
		ALLOW INCORPORATION OF TECHNOLOGICAL ADVANCES	25		
		PROVIDE FOR GEOGRAPHIC EXPANSION	10		
		PROVIDE FOR INCREASED TRAFFIC FLOWS	10		
		OPEN ARCHITECTURE	15		
		-------- SUM --------	100	100	
2. IMPLEMENTATION	a. TIMING	CONGRUENCY WITH OTHER HEADQUARTERS-RELATED PLANS	40	60	20
		FIT WITHIN FISCAL BUDGET CYCLE	60		
		-------- SUM --------	100		
	b. INSTALLATION	DEMAND UPON HEADQUARTERS PERSONNEL	40	40	
		DEGREE OF DISRUPTION TO CRITICAL OPERATIONS	50		
		DURATION OF INSTALLATION/ TRANSITION	10		
		-------- SUM --------	100	100	100

6.2 EVALUATION OF ALTERNATIVE 1 - DATA SWITCH (DS)

In this alternative, the central switch (initially the Northern Telecom SL-100 and in the future an enhanced data PBX) is connected to individual workstations and the clusters of workstations through their respective host controllers. The architecture is a centralized star.

6.2.1 Technical and Implementation

Figure 6-2 presents the overall and individual element weighted scores received by the Data Switch (DS) Alternative. Each of the line item entries is preceded by an initial which indicates the criteria class grouping from which it was derived (see Figure 6-1):

C - Headquarters Compatibility
P - Network System Performance
U - Ease of Use
G - Growth Capacity
T - Timing
I - Installation

The evaluation criteria are listed in order, starting with the highest weight. For example, moves and changes was considered by the USCG LAN Working Group to be the most important criterion and the degree to which the alternative fits the budget as second most important. The dark portion of each criterion bar graph reflects the weighted score that the alternative received. The light portion of the bar graph indicates the highest weighted score that was possible. The actual numeric score (on a scale of 1-100) and weighted value for each element are shown in the two columns to the right.

The Data Switch (DS) received a total weighted score of 688 out of a possible 1000. This alternative was most highly scored for its

- low error rate,
- use of existing facilities,
- minimum maintenance and personnel requirements, and
- ease of installation.

FIGURE 6-2
TECHNICAL AND IMPLEMENTATION EVALUATION
OF
ALTERNATIVE 1 - DATA SWITCH(DS)

	Data Switch	SCORE 688	WEIGHT 1000
G/MOVES & CHNGS		60	80
T/FITS BUDGET		25	72
C/EXIST HDWARE		30	60
C/EXIST PROTOCL		35	50
G/TECH ADVANCES		25	50
P/AVAIL&RELIAB		43	48
P/CONCT&CONCUR		24	48
T/TIMING FITS		34	48
U/DAILY OPNS		34	40
U/MGMT CAPABIL		30	40
I/DISRUPTION		30	40
P/SECURITY		31	36
U/TRAINING REQ		26	32
U/DOCUMNTATION		26	32
I/PERSONNEL		29	32
C/EXIST PROCED		23	30
G/OPEN ARCHTCT		14	30
P/TRAFFIC CAP		16	24
P/TRANS SPEED		16	24
P/MEAS CAPABIL		19	24
P/FAULT CORR		20	24
C/POLICIES		10	20
C/EX PHYS FACIL		18	20

FIGURE 6-2 cont.

TECHNICAL AND IMPLEMENTATION EVALUATION
OF
ALTERNATIVE 1 - DATA SWITCH(DS)

		SCORE	WEIGHT
	Data Switch	688	1000
C/AVAIL RESOURC	[redacted]	15	20
G/GEOG EXPANSN	[redacted]	15	20
G/INCR TRAFFIC	[redacted]	12	20
U/MAINTENANCE	[redacted]	13	16
P/ERROR RATES	[redacted]	12	12
I/INSTL & TRANS	[redacted]	6	8

6.3 EVALUATION OF ALTERNATIVE 2 - BASEBAND (bb)

The Baseband LAN employs distributed switching in a bus topology for approximately 90% of the data communications. The remaining 10% is handled by the SL-100 PBX, either through direct workstation connections or via workstations connected through their host/controller. The LAN backbone high speed data communications use Ethernet baseband technology via single coaxial cables. The 10% handled by the SL-100 use twisted pair telephone wiring.

6.3.1 Technical and Implementation

Figure 6-3 presents the overall and individual criteria weighted values for the Baseband (bb) alternative. As previously noted in the Alternative 1 discussion, the dark portion of each bar reflects the weighted score the alternative achieved for each criterion. The lighter portion of the bar indicates the highest weighted score that was possible. The Baseband (bb) Alternative received a total weighted score of 736 out of a possible 1000. This alternative was most highly scored for its

- o low error rate,
- o openness of architecture,
- o ease of installation, and
- o capacity for geographic expansion.

It was rated lowest for:

- o the degree to which it fits into the Headquarters budget cycle, and
- o its use of existing hardware, facilities, protocols and resources.

6.4 EVALUATION OF ALTERNATIVE 3 - BROADBAND (BB)

The Broadband Alternative employs distributed switching in a tree topology for 90% of the data communications requirements. The remaining 10% is handled by the SL-100 PBX. The LAN broadband backbone uses broadband technology via dual coaxial cables throughout. The 10% of data handled by the SL-100 uses telephone wire.

FIGURE 6-3

TECHNICAL AND IMPLEMENTATION EVALUATION
OF
ALTERNATIVE 2 - BASEBAND (bb)

	SCORE	WEIGHT
baseband	736	1000

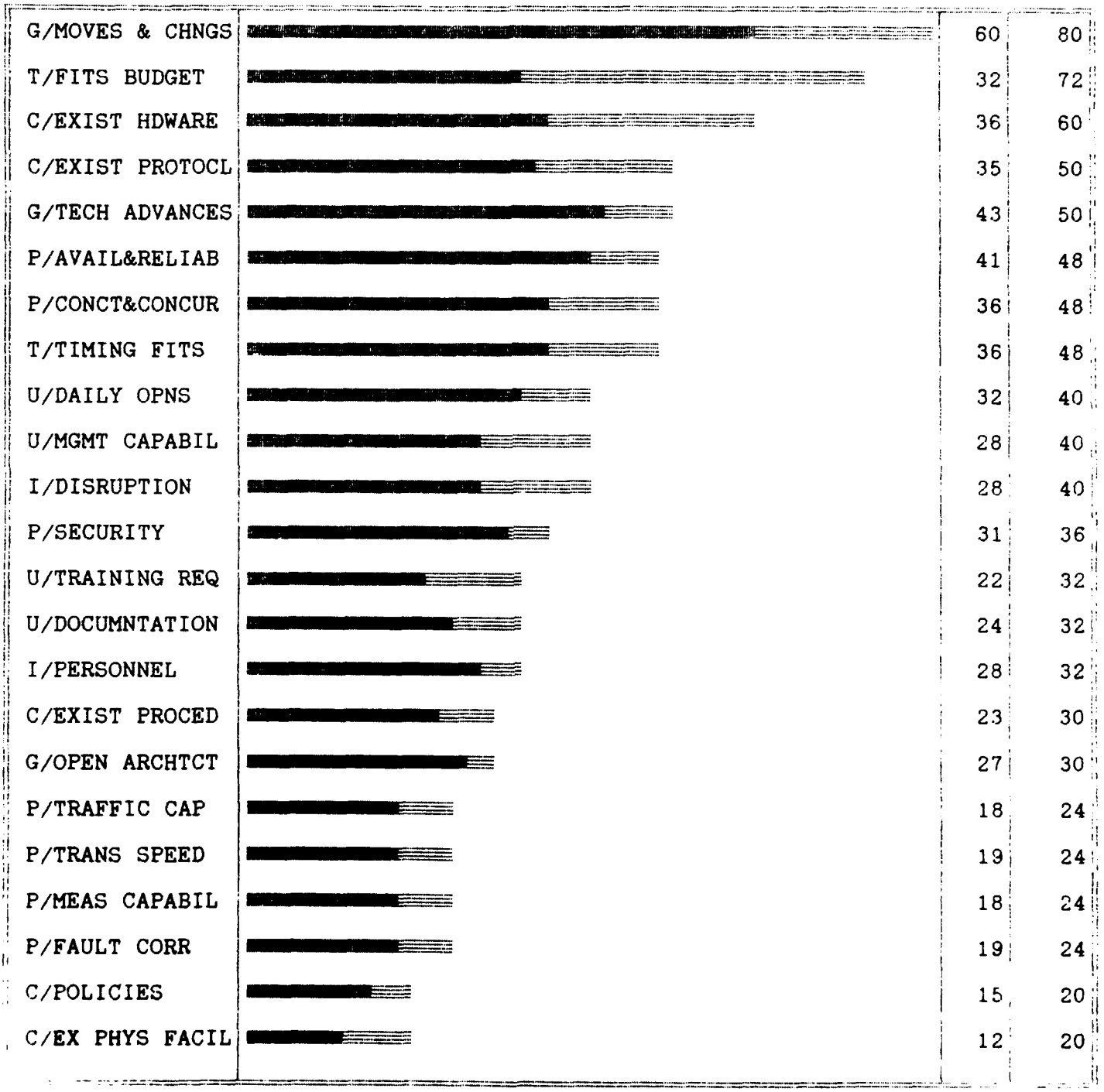


FIGURE 6-3 (cont.)
TECHNICAL AND IMPLEMENTATION EVALUATION
OF
ALTERNATIVE 2 - BASEBAND(bb)

		SCORE	WEIGHT
	baseband	736	1000
C/AVAIL RESOURC	[redacted]	13	20
G/GEOG EXPANSN	[redacted]	16	20
G/INCR TRAFFIC	[redacted]	15	20
U/MAINTENANCE	[redacted]	12	16
P/ERROR RATES	[redacted]	12	12
I/INSTL & TRANS	[redacted]	6	8

6.4.1 Technical and Implementation

Figure 6-4 presents the overall and individual criterion weighted values for the Broadband Alternative. The Broadband (BB) Alternative received a total weighted score of 739 out of a possible 1,000. This alternative was most highly scored for its:

- o traffic carrying capacity,
- o ability to handle future traffic increases,
- o low error rate,
- o transmission speed, and
- o ease of installation.

It was evaluated lowest for its:

- o fit with the Headquarters fiscal budget cycle,
- o use of existing physical facilities and available resources, and
- o potential disruption to critical services during installation.

6.5 EVALUATION OF ALTERNATIVE 4 - HYBRID (Bb)

This alternative employs distributed switching in a tree and baseband/broadband bus topology for 90% of the data communications requirements. The remaining 10% is handled by the SL-100 PBX. The LAN backbone uses dual cable broadband technology; the workstations and host/controllers use a mix of baseband (Ethernet) and broadband technology within clusters, except for 10% of the devices that use the data switch for data communications. The connection of Standard Terminals, Wang, Minicomputer and other terminal devices to the central switch is identical to the levels and distributions indicated for Alternatives 2 and 3.

6.5.1 Technical and Implementation

Figure 6-5 presents the overall and individual criterion weighted values for the Hybrid (Bb) Alternative, which received a total weighted score of 767 out of a possible 1,000. This alternative was most highly scored for its:

- o ability to handle data communications traffic and potential future trafic levels,
- o low error rate,
- o high transmission speed, and
- o openness of architecture.

FIGURE 6-4

TECHNICAL AND IMPLEMENTATION EVALUATION

OF

ALTERNATIVE 3 - BROADBAND (BB)

	SCORE	WEIGHT
BroadBand	739	1000

G/MOVES & CHNGS	76	80
T/FITS BUDGET	25	72
C/EXIST HDWARE	48	60
C/EXIST PROTOCL	35	50
G/TECH ADVANCES	38	50
P/AVAIL&RELIAB	41	48
P/CONCT&CONCUR	36	48
T/TIMING FITS	29	48
U/DAILY OPNS	30	40
U/MGMT CAPABIL	28	40
I/DISRUPTION	26	40
P/SECURITY	31	36
U/TRAINING REQ	24	32
U/DOCUMNTATION	22	32
I/PERSONNEL	27	32
C/EXIST PROCED	23	30
G/OPEN ARCHTCT	23	30
P/TRAFFIC CAP	24	24
P/TRANS SPEED	22	24
P/MEAS CAPABIL	17	24
P/FAULT CORR	19	24
C/POLICIES	14	20
C/EX PHYS FACIL	8	20

FIGURE 6-4 cont.

TECHNICAL AND IMPLEMENTATION EVALUATION

OF

ALTERNATIVE 3 - BROADBAND (BB)

		SCORE	WEIGHT
	BroadBand	739	1000
C/AVAIL RESOURC		12	20
G/GEOG EXPANSN		14	20
G/INCR TRAFFIC		20	20
U/MAINTENANCE		11	16
P/ERROR RATES		12	12
I/INSTL & TRANS		5	8

FIGURE 6-5

TECHNICAL AND IMPLEMENTATION EVALUATION

OF

ALTERNATIVE 4- HYBRID (Bb)

	SCORE	WEIGHT
Hybrid	767	1000

G/MOVES & CHNGS	72	80
T/FITS BUDGET	29	72
C/EXIST HDWARE	48	60
C/EXIST PROTOCL	35	50
G/TECH ADVANCES	45	50
P/AVAIL&RELIAB	43	48
P/CONCT&CONCUR	38	48
T/TIMING FITS	36	48
U/DAILY OPNS	28	40
U/MGMT CAPABIL	32	40
I/DISRUPTION	28	40
P/SECURITY	31	36
U/TRAINING REQ	21	32
U/DOCUMNTATION	21	32
I/PERSONNEL	26	32
C/EXIST PROCED	23	30
G/OPEN ARCHTCT	26	30
P/TRAFFIC CAP	24	24
P/TRANS SPEED	22	24
P/MEAS CAPABIL	19	24
P/FAULT CORR	19	24
C/POLICIES	16	20
C/EX PHYS FACIL	10	20

FIGURE 6-5 cont.

TECHNICAL AND IMPLEMENTATION EVALUATION

OF

ALTERNATIVE 4 - HYBRID (Bb)

		SCORE	WEIGHT
	Hybrid	767	1000
C/AVAIL RESOURC	[redacted]	11	20
G/GEOG EXPANSN	[redacted]	17	20
G/INCR TRAFFIC	[redacted]	20	20
U/MAINTENANCE	[redacted]	11	16
P/ERROR RATES	[redacted]	12	12
I/INSTL & TRANS	[redacted]	5	8

It was rated lowest for its:

- o fit within the Headquarters budget cycle,
- o maintenance requirements,
- o documentation and training requirements, and
- o use of existing physical facilities and available resources.

6.6 SUMMARY

This chapter has presented the results of the technical and implementation evaluation analyses performed on each of the four LAN alternative conceptual designs prepared for USCG Headquarters. Details of the evaluation model and growth model were laid out, and the technical and implementation evaluations of the four LAN alternative conceptual designs were presented individually in both text and graphic form.

CHAPTER 7. COST ANALYSIS

7.1 INTRODUCTION

This chapter describes the cost analysis methodology used (in addition to the Technical and Implementation analyses described in Chapter 6) in evaluating the four LAN alternative conceptual designs. The costing processes applied to each of the four alternatives described below are part of the overall costing methodology defined in Chapter 2. Principal cost assumptions are contained in Appendix F.

7.2 DATA SWITCH (DS) COSTING (ALTERNATIVE 1)

Figure 7-1 shows the projected growth of the data switch. For each of four years (fiscal years 1988 through 1991), the projected data communications networking migration of the four major data communications systems (i.e., Standard Terminals, Wang, Minicomputer and Other Terminals within Headquarters) is presented.

The following major assumptions and projections have been made concerning the growth period for this alternative:

1. The Standard Terminal system will initially attach to the SL-100 switch using low and medium speed communications lines.

2. By fiscal 1990, the number of data lines required across all systems for Headquarters will total over 2,000.

3. The overall Headquarters requirements for data communications in fiscal 1990 will require a major enhancement to the installed SL-100 PBX.

4. High speed lines (above 64,000 bps) will be available for data communications by fiscal 1990, when the SL-100 is enhanced.

5. The majority of Standard Terminal workstations (approximately 700 out of 1200) will use high speed lines and approximately 1,000 will have direct switching capability by fiscal 1991.

6. The Wang system will remain connected as it is presently, i.e., via dual cable between workstation and host/controller and via dual broadband between host/controllers. The host controllers will also be connected directly to the data switch via twisted pair wiring.

FIGURE 7-1
ALTERNATIVE 1 - DATA SWITCH (DS) GROWTH SCHEDULE

MAJOR COMM SYSTEMS	START	END FY 88	END FY 89	END FY 90	END FY 91 +
I. STANDARD TERMINALS	110/1100	110/1100	110/1100	120/1200	120/1200
IS1A (DS)	0	0	0	35/350	70/700
IS1B (DS)	0	2/ 20	4/ 40	9/ 90	10/100
IS1C (LS)	0	14/140	36/360	26/260	16/160
		160	400	700	960
IS1D (STP)	110/1100	94/940	70/700	50/500	24/240
II. MINIS	11/470	11/470	11/470	11/470	11/470
MM1D (1b (C2))	11/470	11/470	11/470	11/470	11/470
III. MINI COMPUTERS	10/200	10/200	10/200	10/200	10/200
MM1B (DS) (40K)	0	32 4/ 80	64 8/160	64 8/160	64 8/160
MM1D (TP)	10/200	6/120	2/ 40	2/ 40	2/ 40
IV. OTHER TERMINALS	225	225	225	300	300
IT1A (DS)	0	0	0	30	30
IT1B (DS)	0	25	25	30	30
IT1C (LS)	0	50	178	240	240
		175	203	300	300
IT1D (TP)	225	150	22	0	0
OTHER MAJOR PROJECTIONS & ASSUMPTIONS					
H/C	131	131	131	141	141
MS	1955	1955	1955	2170	2170
MS DATA PORTS + 50%	0	1267 (+133)	1667 (+333)	11064 (+536)	11324 (+676)
DATA LINES	0	400	1000	1600	2000

LEGEND

1b (C2)	- BASEBAND, 2 CABLES	MS	- HIGH SPEED
BB (PB)	- BROADBAND, PERIPHERAL BAND	LS	- LOW SPEED
BB (MB)	- BROADBAND, MAIN BAND	MS	- MEDIUM SPEED
BB (802.3)	- BROADBAND, ETHERNET	N/A	- NOT APPLICABLE
EDS	- ENHANCED DATA SWITCH	SA	- STAND ALONE
EN (802.3)	- ETHERNET	STP	- SHIELDED TWISTED PAIR
H/C	- HOST/CONTROLLER	TP	- TWISTED PAIR
		WS	- WORKSTATION

7. The minicomputer system will migrate from its present configuration to one having approximately 30% of its workstations directly connected to the data switch by fiscal 1990.

8. All Other Terminals will migrate to having data communication through the switch by fiscal 1991, with 80% of them using low speed lines.

Figure 7-2 shows the transition of the total workstation population for this alternative, from those in place to those networked. For example, in 1987, prior to installing the LAN, the population consisted of just under 2,000 workstations. In fiscal 1988 and 1989 almost 700 workstations would be connected to the data switch. The bar chart reflects the projected increase in the overall Headquarters workstation population and the continued migration of workstation connections to the data switch. By the end of fiscal 1991, all but approximately 850 workstations would be connected to the switch.

Figure 7-3 presents the cost calculated for the Data Switch (DS) Alternative for each of the growth years and beyond, through fiscal 1994. As shown, the costs are divided into two major categories, Acquisition and Recurring. This data is summarized in Figure 7-4. The net present value for Alternative 1 is approximately $4.1 million.

Figure 7-5 reflects how the costs associated with connecting workstations to the switch are shared by the major systems at Headquarters. For example, the connection of Standard Terminal devices to the switch accounts for approximately 90% of the overall LAN cost. This is due to the large overall percentage of Standard Terminal workstations (almost 90%) that are connected to the switch in this alternative and the relatively high cost for the high speed (above 64 KBPS) connections of approximately 75% of these Standard Terminal workstations. The costs shown do not reflect conversion, recurring or net present value adjustments.

7.3 BASEBAND (bb) COSTING - ALTERNATIVE 2

Figure 7-6 presents the projected growth for the baseband alternative. As shown previously for Alternative 1, Figure 7-6 shows each of four years, from fiscal year 1988 through 1991. It indicates the data communications network migration for a baseband LAN for each of the four major data communications systems within Headquarters. The following assumptions and projections were made concerning the LAN growth period:

FIGURE 7-2

ALTERNATIVE 1 - DATA SWITCH (DS) GROWTH SUMMARY

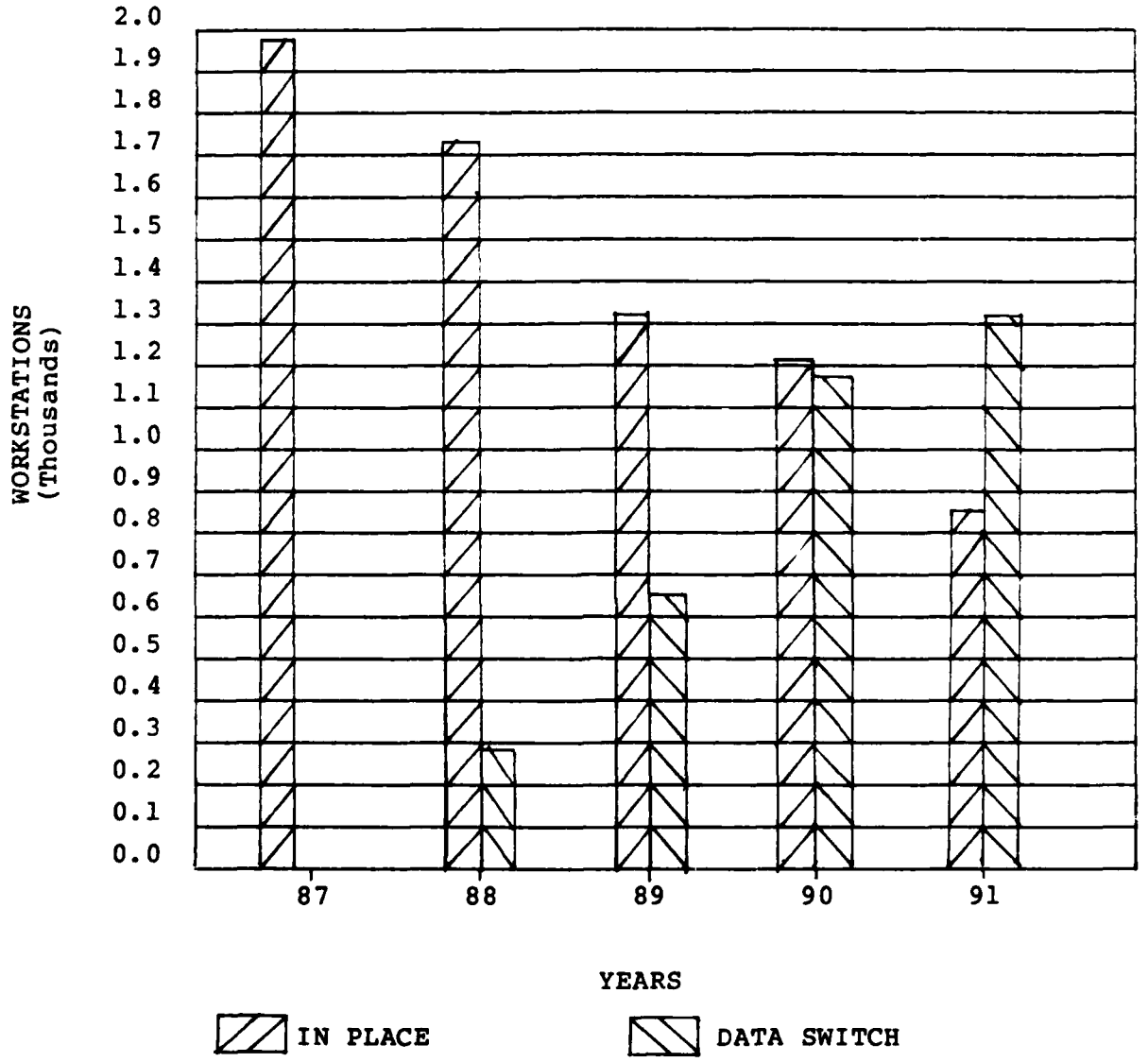


FIGURE 7-3
ALTERNATIVE 1 - DATA SWITCH (DS)
ANNUAL ACQUISITION AND RECURRING COST* MATRIX

ALLOCATION COSTS	ALTERNATIVE # 1						
ACQUISITION	FY88	FY89	FY90	FY91	FY92	FY93	FY94
- CAPITAL							
O MODULE TOTAL COST	787.00	590.00	1845.00	1570.00	0.00	0.00	0.00
O NETWORK CONTROL CENTER	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL CAPITAL COST	787.00	590.00	1845.00	1570.00	0.00	0.00	0.00
- CONVERSION/CUTOVER ** (15%)	118.05	88.50	276.75	235.50	0.00	0.00	0.00
TOTAL ACQUISITION COST	905.05	678.50	2121.75	1805.50	0.00	0.00	0.00
RECURRING							
TOTAL RECURRING COST *** (5%)	39.35	68.85	161.10	239.60	239.60	239.60	239.60
ANNUAL TOTAL COST	944.40	747.35	2282.85	2045.10	239.60	239.60	239.60

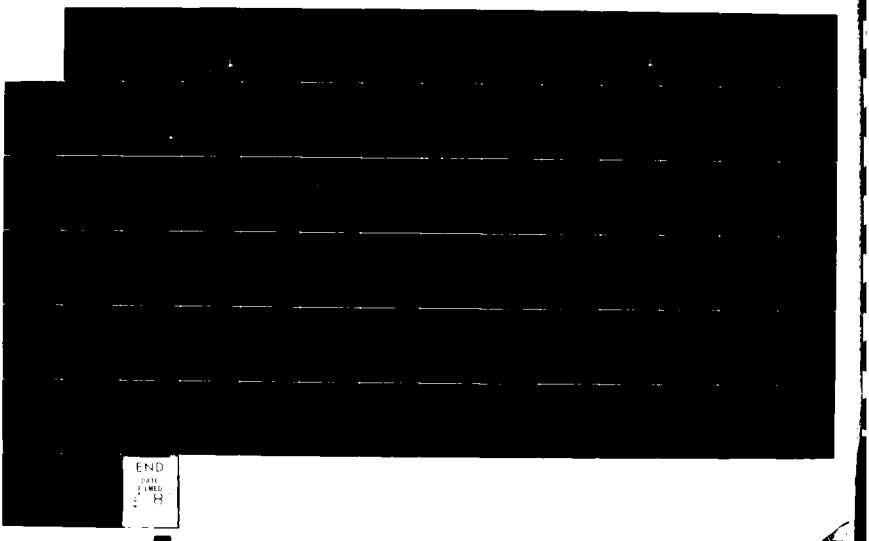
* ALL COSTS IN THOUSANDS OF DOLLARS
** INCLUDES: TRAINING & MANAGEMENT
*** OPERATION & MAINTENANCE e.g.
STAFF, FACILITIES, SUPPLIES & PARTS

FIGURE 7-4
ALTERNATIVE 1 - DATA SWITCH (DS)
ANNUAL SUMMARY AND CUMULATIVE COST* CHART

DATA SWITCH								
MAJOR COST AREAS	FY88	FY89	FY90	FY91	FY92	FY93	FY94	TOTAL	NPV**
ACQUISITION	905.05	678.50	2121.75	1805.50	0.00	0.00	0.00	5510.80	3576.49
RECURRING	39.35	68.85	161.10	239.60	239.60	239.60	239.60	1227.70	565.48
TOTAL	944.40	747.35	2282.85	2045.10	239.60	239.60	239.60	6738.50	4141.97

* ALL COSTS IN THOUSANDS OF DOLLARS
** DISCOUNT RATE = 0.10

AD-A178 218 UNITED STATES COAST GUARD LOCAL AREA NETWORK (LAN) 2/2
FEASIBILITY ANALYSIS R..(U) WILSON-HILL ASSOCIATES INC
WASHINGTON DC FEB 87 USCG-ITS-0003-87-VOL-1
UNCLASSIFIED DTCG23-85-A-50031 F/G 17/2 NL



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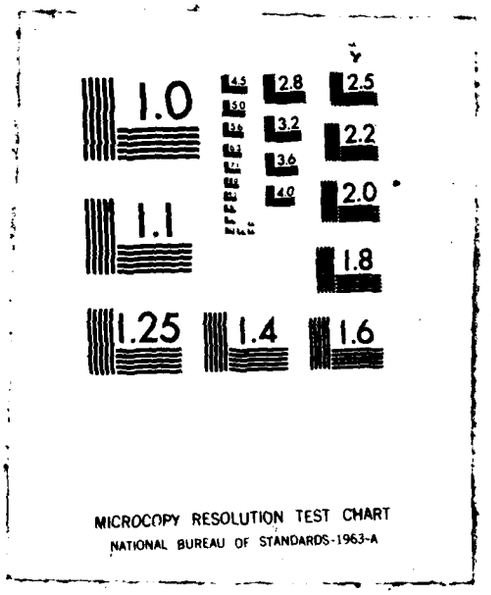
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2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FIGURE 7-5

ALTERNATIVE 1 - DATA SWITCH LAN ACQUISITION COST
BY WORKSTATION TYPE

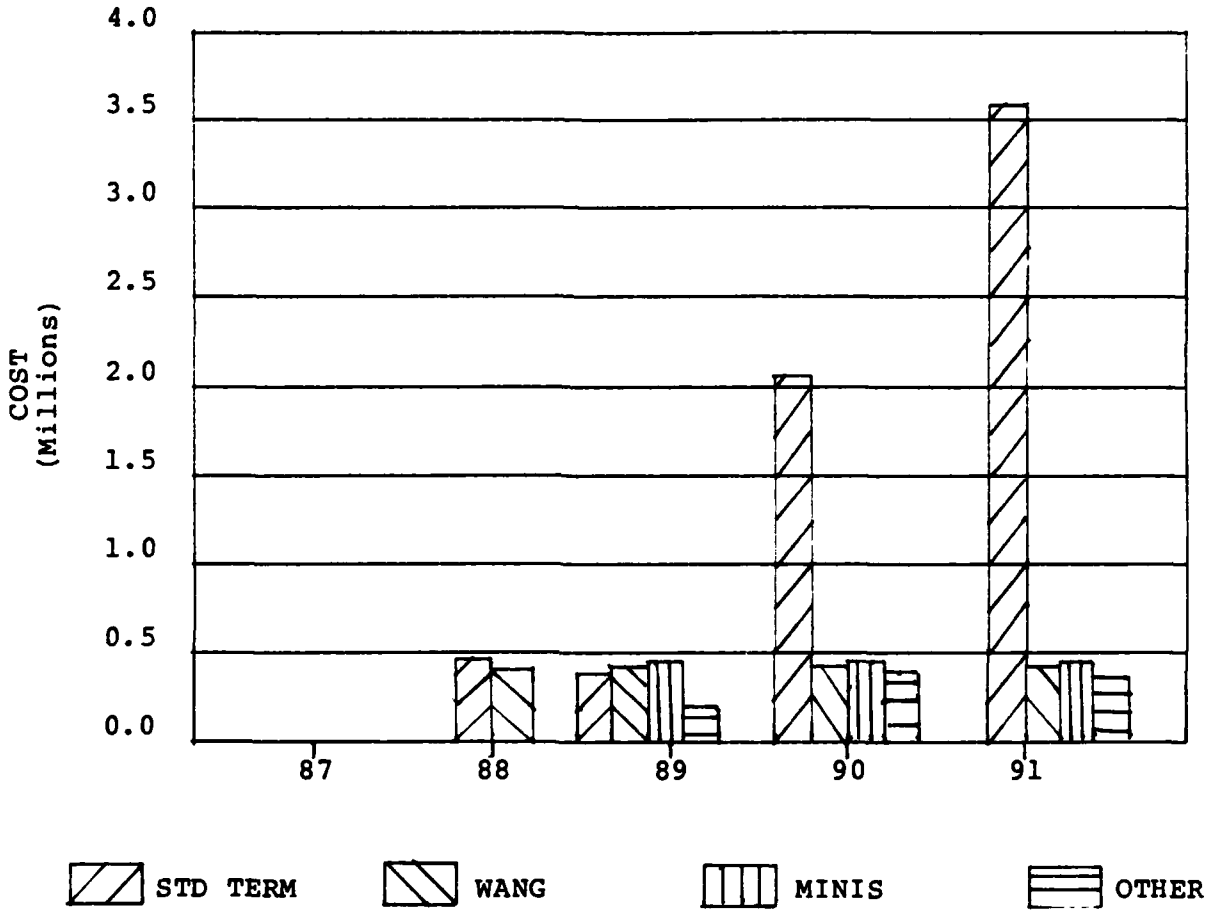


FIGURE 7-6
ALTERNATIVE 2 - BASEBAND (bb) GROWTH SCHEDULE

MAJOR CSMA SYSTEMS	START	END FY 88	END FY 89	END FY 90	END FY 91 +
I. STANDARD TERMINALS	110/1100	110/1100	110/1100	120/1200	120/1200
S2A (BB)	0	0	0	0	0
S2B (BB)	0	2/ 20	2/ 20	4/ 40	6/ 60
S2C (LS)	0	14/140	14/140	12/120	10/100
		---	---	---	---
		160	160	160	160
S2D (STP)	110/1100	96/960	61/610	32/320	0
S2E (EN (802.3))	0	0	33/330 (30%T)	72/720 (60%T)	104/1040 (85%T)
II. MINIS	11/470	11/470	11/470	11/470	11/470
MID (bb (C2))	11/470	11/470	11/470	11/470	11/470
III. MINI COMPUTERS	10/200	10/200	10/200	10/200	10/200
MID (HS) (40K)	0	32 4/ 80	48 6/120	32 4/ 80	16 2/ 40
MID (TP)	10/200	6/120	1/ 20	0	0
MEE (EN (802.3))	0	0	60 3/ 60 (30%T)	120 6/120 (60%T)	160 8/160 (80%T)
IV. OTHER TERMINALS	225	225	225	300	300
T2A (HS)	0	0	0	0	0
T2B (MS)	0	5	20	25	20
T2C (LS)	0	50	39	50	40
		---	---	---	---
		175	159	175	160
T2D (STP)	225	150	96	45	0
T2E (EN (802.3))	0	0	70 (30%T)	180 (60%T)	240 (80%T)
OTHER MAJOR PROJECTIONS & ASSUMPTIONS					
M/C	131	131	131	141	141
MS	1995	1995	1995	2170	2170
MS DATA PORTS + 50%	0	1267 (+133)	1267 (+133)	1267 (+133)	1236 (+164)
DATA LINES	0	400	400	400	400

LEGEND

bb (C2)	- BASEBAND, 2 CABLES	MS	- HIGH SPEED
BB (PB)	- BROADBAND, PERIPHERAL BAND	LS	- LOW SPEED
BB (HB)	- BROADBAND, HOST BAND	MS	- MEDIUM SPEED
BB (802.3)	- BROADBAND, ETHERNET	N/A	- NOT APPLICABLE
EDS	- ENHANCED DATA SWITCH	SA	- STAND ALONE
EN (802.3)	- ETHERNET	STP	- SHIELDED TWISTED PAIR
M/C	- HOST/CONTROLLER	TP	- TWISTED PAIR
		WS	- WORKSTATION

1. The Standard Terminal system will have a total of 160 workstations and 16 host/controllers attached to the SL-100, using low and medium speed lines. The balance, or 85% of Standard Terminal workstations and host/controllers, will migrate from their present wiring configuration to being attached directly to an Ethernet 802.3 baseband network.

2. The Wang system will continue to be connected as it is presently, i.e. via dual cable between workstation and host/controller and via dual cable broadband between host/controllers. The host/controllers will be connected directly to the data switch via twisted pair cable.

3. The Minicomputer system will level off to a total of approximately 16 workstations, with all host/controllers attached to the SL-100 using medium speed lines. The majority of the remainder, 90% of the minicomputer workstations, will migrate from their present wiring configuration to being attached directly to an Ethernet 802.3 baseband network.

4. With the exception of 20% of the Other Terminals, all standalone workstations will gradually be attached to an Ethernet 802.3 baseband network. By fiscal 1991, there will not be any Other Terminals workstations which do not have switching capability. The 20% not on baseband will be connected to the SL-100 via low and medium speed lines.

Figure 7-7 shows the transition of in-place workstations to a mix of in-place data switch (260) and baseband (1440) connections by fiscal 1991.

Figure 7-8 presents the cost calculated for the Baseband (bb) Alternative for each of the growth years and beyond through fiscal 1994. As previously shown for Alternative 1, the costs are divided into two major categories, Acquisition and Recurring. This data is summarized in Figure 7-9. The net present value for Alternative 2 is approximately $2.7 million.

Figure 7-10 reflects the acquisition costs for networking each of the Headquarters systems. Again, because of the

FIGURE 7-7

ALTERNATIVE 2 - BASEBAND (bb) GROWTH SUMMARY

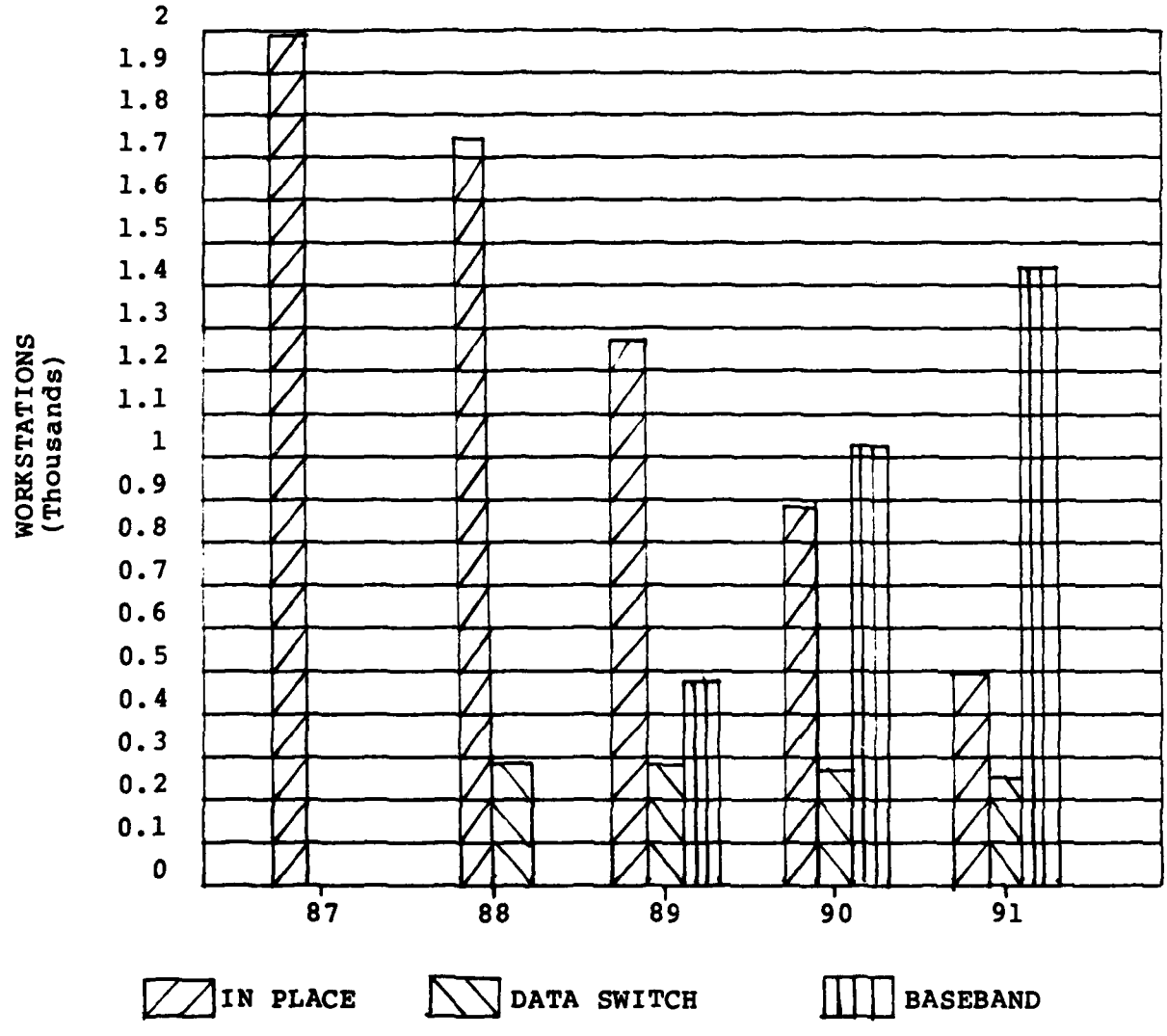


FIGURE 7-8
ALTERNATIVE 2 - BASEBAND (bb)
ANNUAL ACQUISITION AND RECURRING COST* MATRIX

ALLOCATION COSTS	ALTERNATIVE # 2						
ACQUISITION	FY88	FY89	FY90	FY91	FY92	FY93	FY94
- CAPITAL							
0 MODULE TOTAL COST	787.00	635.00	778.00	585.00	0.00	0.00	0.00
0 NETWORK CONTROL CENTER	25.00	15.00	10.00	0.00	0.00	0.00	0.00
TOTAL CAPITAL COST	812.00	650.00	788.00	585.00	0.00	0.00	0.00
- CONVERSION/CUTOVER ** (15%)	121.80	97.50	118.20	87.75	0.00	0.00	0.00
TOTAL ACQUISITION COST	933.80	747.50	906.20	672.75	0.00	0.00	0.00
RECURRING							
TOTAL RECURRING COST *** (5%)	40.60	73.10	112.50	141.75	141.75	141.75	141.75
ANNUAL TOTAL COST	974.40	820.60	1018.70	814.50	141.75	141.75	141.75

* ALL COSTS IN THOUSANDS OF DOLLARS
** INCLUDES: TRAINING & MANAGEMENT
*** OPERATION & MAINTENANCE e.g.
STAFF, FACILITIES, SUPPLIES & PARTS

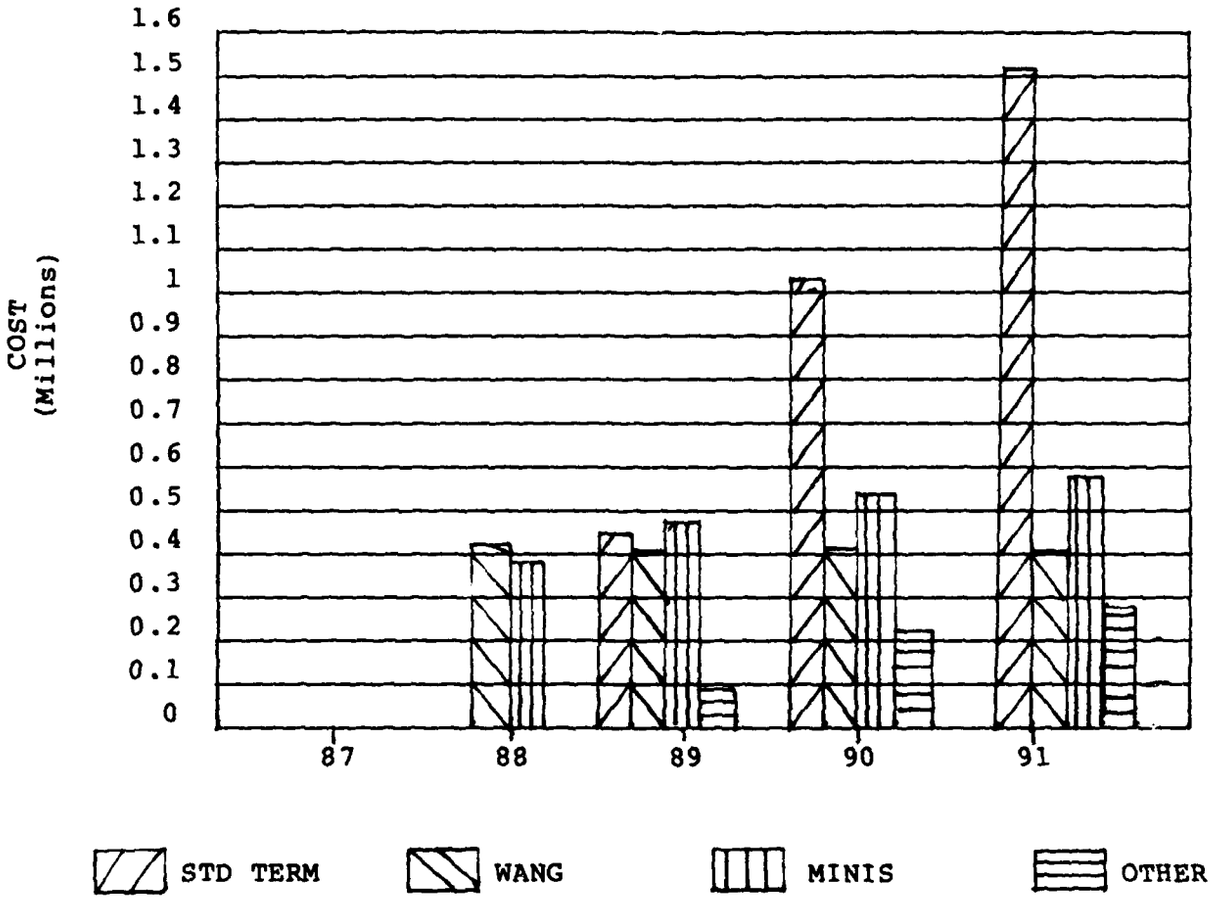
FIGURE 7-9
ALTERNATIVE 2 - BASEBAND (bb)
ANNUAL SUMMARY AND CUMULATIVE COST* CHART

BASEBAND									
MAJOR COST AREAS	FY88	FY89	FY90	FY91	FY92	FY93	FY94	TOTAL	NPV**
ACQUISITION	933.80	747.50	906.20	672.75	0.00	0.00	0.00	3260.25	2318.42
RECURRING	40.60	73.10	112.50	141.75	141.75	141.75	141.75	793.20	385.28
TOTAL	974.40	820.60	1018.70	814.50	141.75	141.75	141.75	4053.45	2703.71

* ALL COSTS IN THOUSANDS OF DOLLARS
** DISCOUNT RATE = 0.10

FIGURE 7-10

ALTERNATIVE 2 - BASEBAND LAN ACQUISITION COST
BY WORKSTATION TYPE



high proportion of Standard Terminal workstations involved, this system accounts for the major networking cost. Costs shown do not reflect conversion, recurring or net present value adjustments.

7.4 BROADBAND (BB) COSTING - ALTERNATIVE 3

Figure 7-11 presents the projected growth for a broadband network. Over the growth period the following assumptions and projections are made:

1. The Standard Terminal system will have a portion of its workstations and host/controllers attached to the SL-100 as in Alternative 2. The balance of the Standard Terminal devices (approximately 90%) will migrate from their present wiring configurations to also being attached directly to a dual coaxial cable WANGNET type broadband network.

2. The Wang system will migrate to a dual coaxial broadband network. Twenty percent (20%) will remain attached to their host/controllers as they are currently.

3. The Minicomputers will migrate toward having approximately 10% of their workstations connected to the SL-100 and 80% connected to a dual coaxial broadband network and 10% remaining connected as they are currently.

4. Eighty percent of the Other Terminal workstations will gradually be attached to a dual coaxial broadband network. The balance will be connected to the SL-100 in a mix of medium and low speed connections.

Figure 7-12 shows the transition of workstations for this alternative. The broadband connections build up to a fiscal 1991 total of approximately 1,800 connections.

Figure 7-13 presents the costs determined for the Broadband (BB) Alternative for each of the growth years and beyond through fiscal 1994. This data is summarized in Figure 7-14. The net present value cost for Alternative 3 is estimated to be approximately $3.1 million.

Figure 7-15 reflects the capital acquisition costs associated with networking each of the Headquarters systems. Costs shown do not reflect conversion, recurring or net present value adjustments.

FIGURE 7-11
ALTERNATIVE 3 - BROADBAND (BB) GROWTH SCHEDULE

MAJOR CBMD SYSTEMS	START	END FY 88	END FY 89	END FY 90	END FY 91 +
II. STANDARD TERMINALS	110/1100	110/1100	110/1100	120/1200	120/1200
[illegible]	0	0	0	0	0
[illegible]	0	2/ 20	2/ 20	4/ 40	6/ 60
[illegible]	0	14/140	14/140	12/120	10/100
		—	—	—	—
		160	160	160	160
[illegible] (STP)	110/1100	94/940	83/830	56/560	0
[illegible] (BB (PB))	0	0	11/110 (10%T)	48/480 (40%T)	104/1040 (85%T)
III. [illegible]	11/470	11/470	11/470	11/470	11/470
[illegible] (bb (C2))	11/470	11/470	10/427	7/298	3/126
[illegible] (BB (PB))	0	0	43 1/ 43 (10%T)	172 4/172 (10%T)	344 8/344 (80%T)
IIII. [illegible]	10/200	10/200	10/200	10/200	10/200
[illegible] (4Mb)	0	32 4/ 80	48 6/120	48 6/120	16 8/ 40
[illegible] (TP)	10/200	6/120	4/ 80	1/ 20	0
[illegible] (BB (PB))	0	0	20 1/20 (10%T)	80 4/ 80 (40%T)	160 8/160 (80%T)
IV. [illegible]	225	225	225	300	300
[illegible]	0	0	0	0	0
[illegible]	0	25	20	20	20
[illegible]	0	50	39	39	40
		—	—	—	—
		175	159	159	160
[illegible] (SBN)	225	150	146	121	0
[illegible] (BB (PB))	0	0	20 (10%T)	120 (40%T)	240 (80%T)
OTHER MAJOR PROJECTIONS & ASSUMPTIONS					
H/C	131	131	131	141	141
WS	1955	1955	1955	2170	2170
WS DATA PORTS + 50%	0	1267 (+133)	1267 (+133)	1267 (+133)	1236 (+164)
DATA LINES	0	400	400	400	400

LEGEND

bb (C2)	- BASEBAND, 2 CABLES	HS	- HIGH SPEED
BB (PB)	- BROADBAND, PERIPHERAL BOARD	LS	- LOW SPEED
BB (MB)	- BROADBAND, MAIN BOARD	MS	- MEDIUM SPEED
BB (802.3)	- BROADBAND, ETHERNET	N/A	- NOT APPLICABLE
EDS	- ENHANCED DATA SWITCH	SA	- STAND ALONE
EN (802.3)	- ETHERNET	STP	- SHIELDED TWISTED PAIR
H/C	- HOST/CONTROLLER	TP	- TWISTED PAIR
		WS	- WORKSTATION

FIGURE 7-12

ALTERNATIVE 3 - BROADBAND (BB) GROWTH SUMMARY

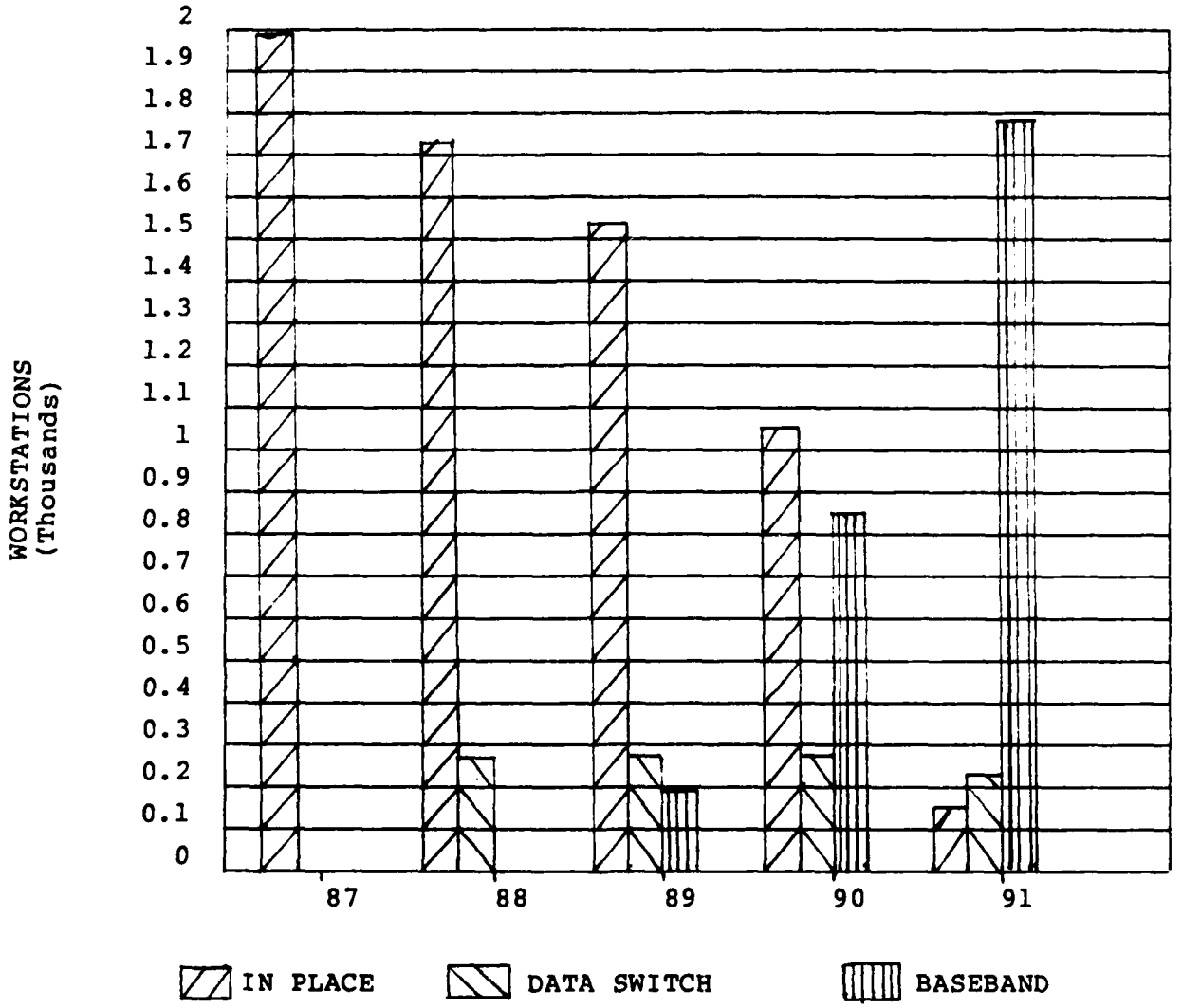


FIGURE 7-13
ALTERNATIVE - 3 BROADBAND (BB)
ANNUAL ACQUISITION AND RECURRING COST* MATRIX

ALLOCATION COSTS	ALTERNATIVE # 3						
ACQUISITION	FY88	FY89	FY90	FY91	FY92	FY93	FY94
- CAPITAL							
O MODULE TOTAL COST	787.00	323.00	995.00	1407.00	0.00	0.00	0.00
O NETWORK CONTROL CENTER	25.00	15.00	10.00	0.00	0.00	0.00	0.00
TOTAL CAPITAL COST	812.00	338.00	1005.00	1407.00	0.00	0.00	0.00
- CONVERSION/CUTOVER ** (15%)	121.80	50.70	150.75	211.05	0.00	0.00	0.00
TOTAL ACQUISITION COST	933.80	388.70	1155.75	1618.05	0.00	0.00	0.00
RECURRING							
TOTAL RECURRING COST *** (5%)	40.60	57.50	107.75	178.10	178.10	178.10	178.10
ANNUAL TOTAL COST	974.40	446.20	1263.50	1796.15	178.10	178.10	178.10

* ALL COSTS IN THOUSANDS OF DOLLARS
** INCLUDES: TRAINING & MANAGEMENT
*** OPERATION & MAINTENANCE e.g.
STAFF, FACILITIES, SUPPLIES & PARTS

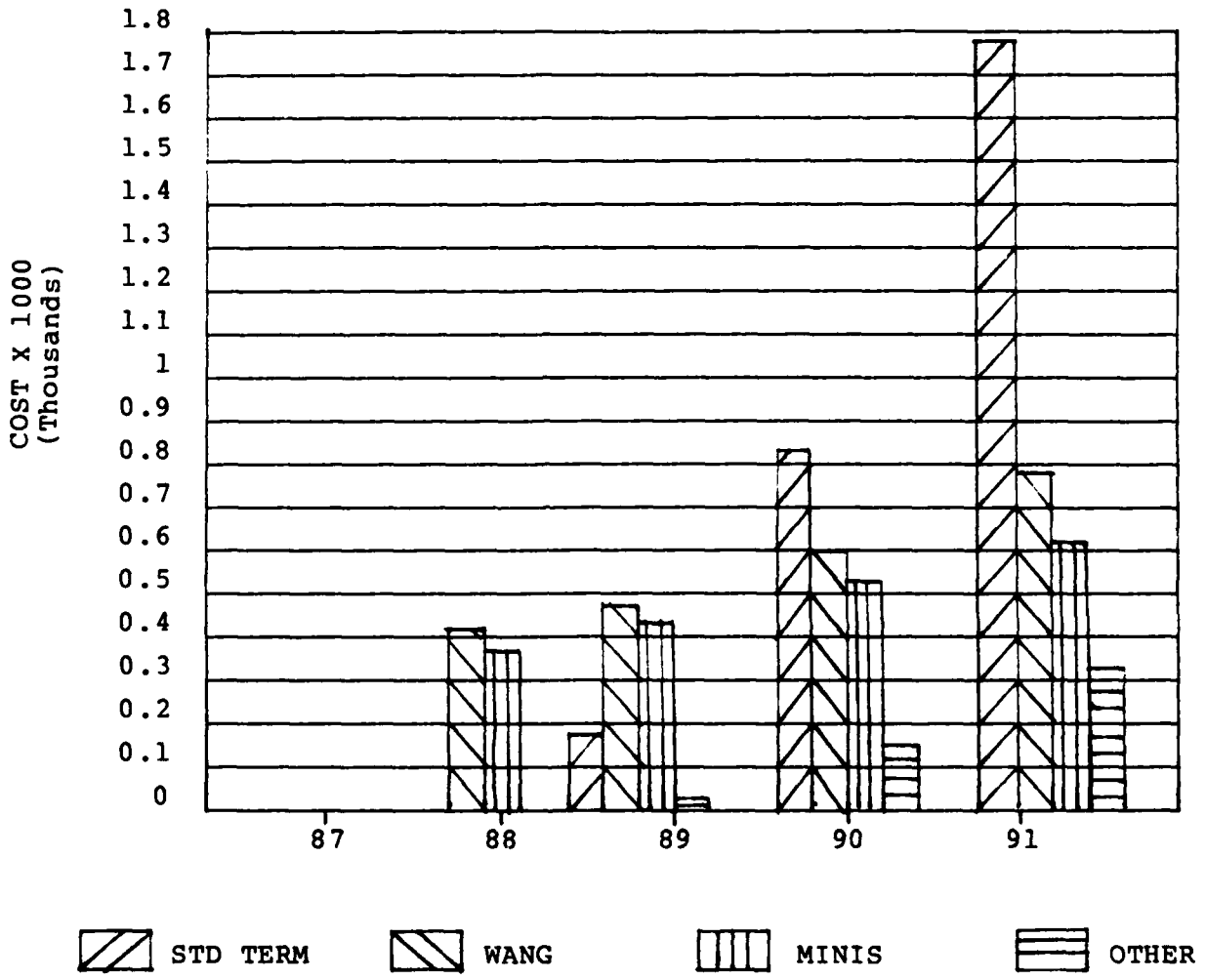
FIGURE 7-14
ALTERNATIVE 3 - BROADBAND (BB)
ANNUAL SUMMARY AND CUMULATIVE COST* CHART

BROADBAND									
MAJOR COST AREAS	FY88	FY89	FY90	FY91	FY92	FY93	FY94	TOTAL	NPV**
ACQUISITION	933.80	388.70	1155.75	1618.05	0.00	0.00	0.00	4096.30	2688.89
RECURRING	40.60	57.50	107.75	178.10	178.10	178.10	178.10	918.25	427.95
TOTAL	974.40	446.20	1263.50	1796.15	178.10	178.10	178.10	5014.55	3116.84

* ALL COSTS IN THOUSANDS OF DOLLARS
** DISCOUNT RATE = 0.10

FIGURE 7-15

ALTERNATIVE 3 - BROADBAND LAN ACQUISITION COST
BY WORKSTATION TYPE



7.5 HYBRID (Bb) COSTING - ALTERNATIVE 4

Figure 7-16 presents the projected growth for Alternative 4. Over the growth period the following assumptions and projections are made:

1. The Standard Terminal system will have workstations and host/controllers attached to the SL-100, as in Alternatives 2 and 3. The balance of the Standard Terminal devices will migrate from their present wiring configuration to being attached, on an approximately equal basis, to a baseband Ethernet 802.3 network or a broadband dual cable Wang type network.

2. The Wang system devices will be wired as presented previously for Alternative 3; i.e. 80% will migrate to a dual cable broadband network and 20% will remain attached to their host controllers as they are currently.

3. By fiscal 1991, the Minicomputer devices will be connected in part (approximately 10%) to the SL-100 by medium speed connections and as they are currently (10%). The balance of devices (80%) will be divided equally between a baseband Ethernet 802.3 network and a dual coaxial broadband network over an Ethernet 802.3 channel.

4. By the end of the growth period, 20% of the Other Terminals workstations will be connected to the SL-100 via low and medium speed connections. The balance will be equally divided between a baseband Ethernet 802.3 network and a dual coaxial broadband network over an Ethernet 802.3 channel.

Figure 7-17 shows the transition of workstations to a fiscal 1991 mix of in-place, data switch (approximately 240), baseband (approximately 720) and broadband (approximately 1,100) connections.

Figure 7-18 presents the cost determined for the Hybrid (Bb) Alternative for each of the growth years and beyond through fiscal 1994. This data is summarized in Figure 7-19. The net present value cost for Alternative 4 is approximately $3.1 million.

FIGURE 7-16
ALTERNATIVE 4 - HYBRID (Bb) GROWTH SCHEDULE

MAJOR C&W SYSTEMS	START	END FY 88	END FY 89	END FY 90	END FY 91 +
I. STANDARD TERMINALS	110/1100	110/1100	110/1100	120/1200	120/1200
SAA (HS)	0	0	0	0	0
SAB (MS)	0	2/ 20	2/ 20	4/ 40	6/ 60
SAC (LS)	0	14/140	14/140	12/120	10/100
		---	---	---	---
		160	160	160	160
SAD (STP)	110/1100	94/940	64/640	32/320	0
SAE (EN (802.3))	0	0	27/270 (27%T)	36/360 (30%T)	52/520 (43%T)
SAG (BB (802.3))	0	0	3/ 30 (3%T)	36/360 (30%T)	52/520 (43%T)
II. MMBS	11/470	11/470	11/470	11/470	11/470
MAB (Bb (C2))	11/470	11/470	10/427	7/298	3/126
MAF (BB (PB))	0	0	43 1/ 43 (10%T)	172 7/172 (40%T)	344 8/344 (80%T)
III. MINI COMPUTERS	10/200	10/200	10/200	10/200	10/200
MAB (HS) (40%)	0	32 4/ 80	48 6/120	48 6/120	16 2/ 40
MAB (TP)	10/200	6/120	3/ 60	1/ 20	0
MAE (EN(802.3))	0	0	20 1/ 20 (10%T)	40 2/ 40 (20%T)	80 4/ 80 (40%T)
MAG (BB (802.3))	0	0	20 1/ 20 (10%T)	40 2/ 40 (20%T)	80 4/ 80 (40%T)
IV. OTHER TERMINALS	225	225	225	300	300
T4A (HS)	0	0	0	0	0
T4B (MS)	0	25	20	25	20
T4C (LS)	0	50	39	50	40
		--	---	--	--
		75	159	75	160
T4D (STP)	225	150	101	45	0
T4E (EN (802.3))	0	0	45 (20%T)	90 (30%T)	120 (40%T)
T4G (BB (802.3))	0	0	20 (10%T)	90 (30%T)	120 (40%T)
OTHER MAJOR PROJECTIONS & ASSUMPTIONS					
H/C	131	131	131	141	141
WS	1995	1995	1995	2170	2170
WS DATA PORTS + 50%	0	1267 (+133)	1267 (+133)	1267 (+133)	1236 (+164)
DATA LINES	0	400	400	400	400

LEGEND

Bb (C2)	- BASEBAND, 2 CABLES	HS	- HIGH SPEED
BB (PB)	- BROADBAND, PERIPHERAL BAND	LS	- LOW SPEED
BB (MB)	- BROADBAND, MMBS BAND	MS	- MEDIUM SPEED
BB (802.3)	- BROADBAND, ETHERNET	N/A	- NOT APPLICABLE
EBS	- ENHANCED DATA SWITCH	SA	- STAND ALONE
EN (802.3)	- ETHERNET	STP	- SHIELDED TWISTED PAIR
H/C	- HOST/CONTROLLER	TP	- TWISTED PAIR
		WS	- WORKSTATION

FIGURE 7-17

ALTERNATIVE 4 - HYBRID (Bb) GROWTH SUMMARY

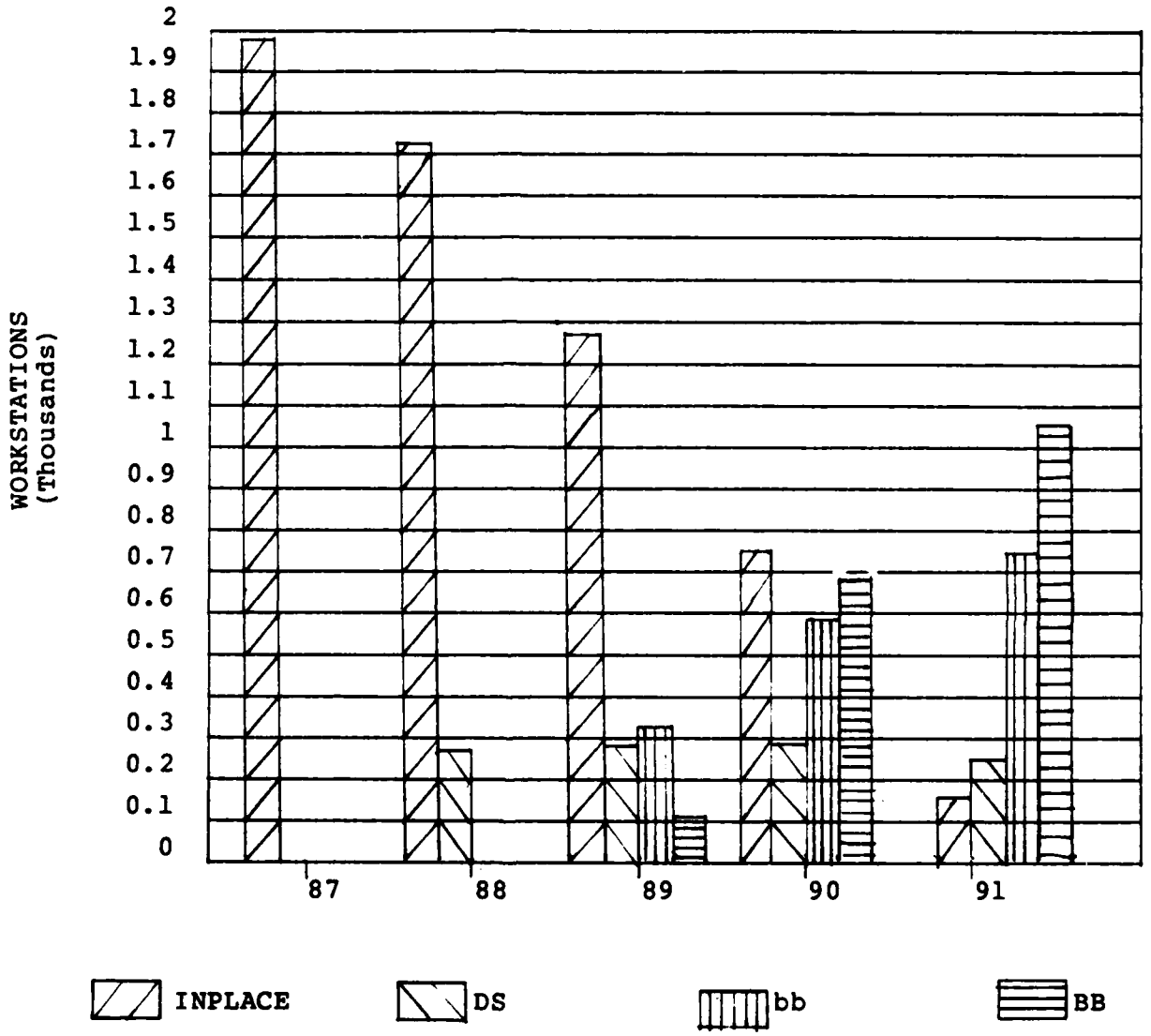


FIGURE 7-18

ALTERNATIVE 4 - HYBRID (Bb)

ANNUAL ACQUISITION AND RECURRING COST* MATRIX

ALLOCATION COSTS	ALTERNATIVE # 4						
ACQUISITION	FY88	FY89	FY90	FY91	FY92	FY93	FY94
- CAPITAL							
0 MODULE TOTAL COST	787.00	645.00	1045.00	898.00	0.00	0.00	0.00
0 NETWORK CONTROL CENTER	25.00	15.00	10.00	0.00	0.00	0.00	0.00
TOTAL CAPITAL COST	812.00	660.00	1055.00	898.00	0.00	0.00	0.00
- CONVERSION/CUTOVER ** (15%)	121.80	99.00	158.25	134.70	0.00	0.00	0.00
TOTAL ACQUISITION COST	933.80	759.00	1213.25	1032.70	0.00	0.00	0.00
RECURRING							
TOTAL RECURRING COST *** (5%)	40.60	73.60	126.35	171.25	171.25	171.25	171.25
ANNUAL TOTAL COST	974.40	832.60	1339.60	1203.95	171.25	171.25	171.25

* ALL COSTS IN THOUSANDS OF DOLLARS

** INCLUDES: TRAINING & MANAGEMENT

*** OPERATION & MAINTENANCE e.g.
STAFF, FACILITIES, SUPPLIES & PARTS

FIGURE 7-19
ALTERNATIVE 4 - HYBRID (Bb)
ANNUAL SUMMARY AND CUMULATIVE COST* CHART

DATA SWITCH								
MAJOR COST AREAS	FY88	FY89	FY90	FY91	FY92	FY93	FY94	TOTAL	NPV**
ACQUISITION	933.80	759.00	1213.25	1032.70	0.00	0.00	0.00	3938.75	2702.43
RECURRING	40.60	73.60	126.35	171.25	171.25	171.25	171.25	925.55	440.79
TOTAL	974.40	832.60	1339.60	1203.95	171.25	171.25	171.25	4864.30	3143.22

* ALL COSTS IN THOUSANDS OF DOLLARS
** DISCOUNT RATE = 0.10

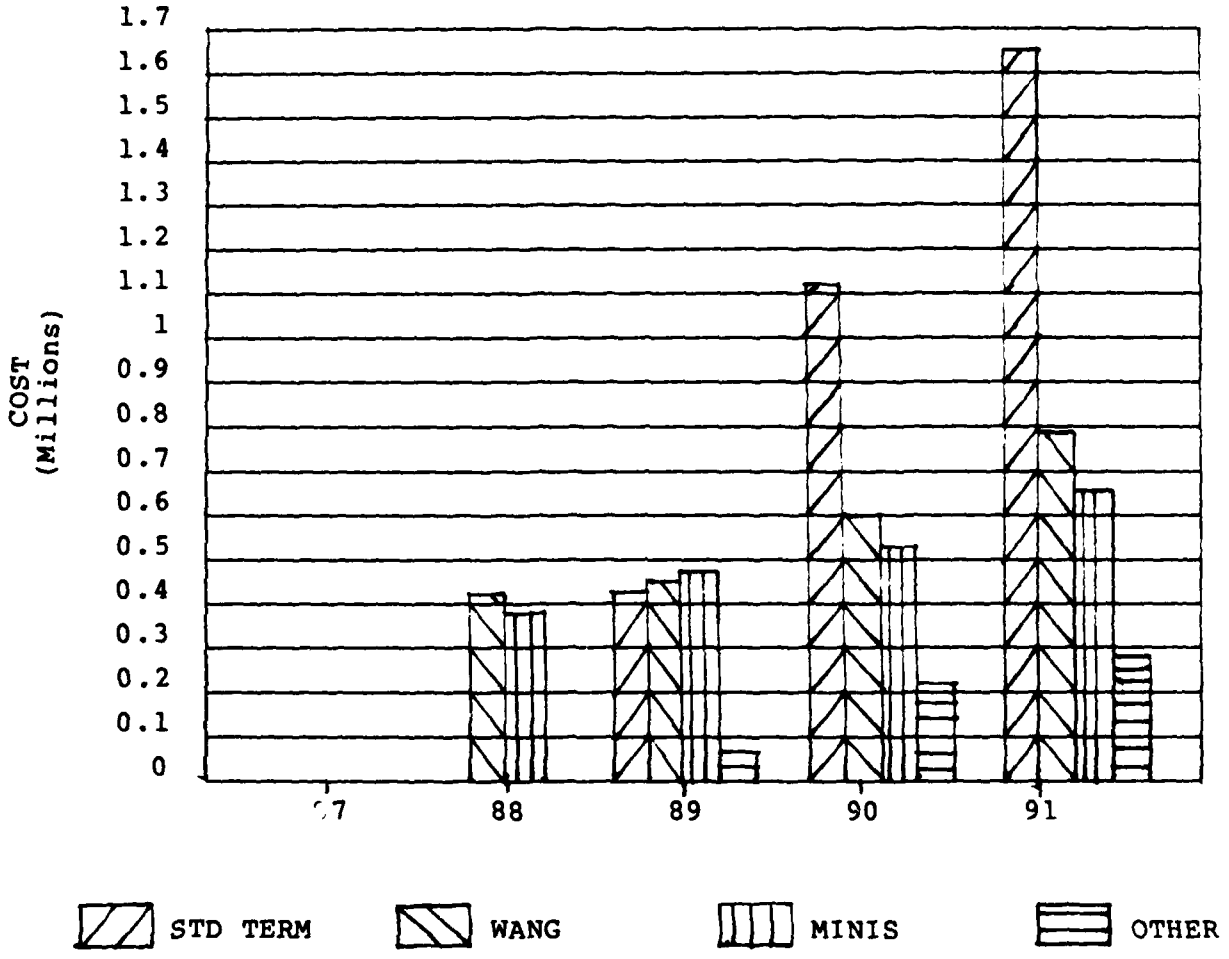
Figure 7-20 reflects the acquisition costs associated with networking each of the Headquarters systems. The costs shown do not reflect conversion, recurring or net present value adjustments.

7.6 SUMMARY

This chapter has presented the cost analyses performed on each of the four LAN alternative conceptual designs.

FIGURE 7-20

ALTERNATIVE 4 - HYBRID LAN ACQUISITION COST
BY WORKSTATION TYPE



CHAPTER 8. COMPARATIVE ANALYSIS

8.1 INTRODUCTION

This chapter consists of an analysis of the scores received by the various alternatives on a criterion-by-criterion basis. A difference of seven points or less is not considered significant and is not commented upon (see Table 8-1.) The chapter also contains a comparison of the alternatives' costs.

8.2 DATA SWITCH (DS) - ALTERNATIVE 1

The primary characteristic of this alternative is its ease of network design.

The score that was received by Alternative 1 was 688 out of a possible 1,000 points. The range between the highest and lowest scored alternatives was 688 (DS), and 767 (Bb), or 79 points.

8.2.1 Data Switch (DS) vs. Baseband (bb)

The comparative scores for Alternatives 1 and 2 are 688 and 736, respectively, with the Baseband (bb) Alternative 2 being favored.

There are no significant advantages of Alternative 1 over Alternative 2.

The disadvantages of this alternative compared to Alternative 2 are primarily in the following areas:

- Fits Budget.....: this alternative received a score of 25 compared to a score of 32 for Alternative 2.
- Technical Advances...: this alternative received a score of 25 compared to a score of 43 for Alternative 2.
- Connectivity and Concurrency...: this alternative received a score of 24 compared to a score of 36 for Alternative 2.
- Open Architecture...: this alternative received a score of 14 compared to a score of 27 for Alternative 2.

The primary reason for the scoring differences between the two Alternatives is the expected flexibility of the Baseband (bb) Alternative to incorporate new technology into the network as technical advances are made.

8.2.2 Data Switch (DS) vs. Broadband (BB)

The comparative scores for Alternatives 1 and 3 are 688 and 739, respectively, with the Broadband (BB) Alternative 3 being favored. Comparative scoring of the detailed criteria between the Data Switch (DS) and the Broadband (BB) Alternatives is shown in Table 8-1.

There are no significant advantages of this alternative over Alternative 3.

The disadvantages of this alternative compared to Alternative 3 are primarily in the following areas:

- Moves and Changes...: this alternative received a score of 60 compared to a score of 76 for Alternative 3.
- Existing Hardware/Software...: this alternative received a score of 30 compared to a score of 48 for Alternative 3.
- Technical Advances...: this alternative received a score of 25 compared to a score of 38 for Alternative 3.
- Connectivity and Concurrency...: this alternative received a score of 24 compared to a score of 36 for Alternative 3.
- Open Architecture...: this alternative received a score of 14 compared to a score of 23 for Alternative 3.
- Traffic Carrying Capacity...: this alternative received a score of 16 compared to a score of 24 for Alternative 3.

The primary reason for the scoring differences between the two alternatives is compatibility with existing hardware/software, where a broadband LAN can use a segmented network approach and different channels to connect to existing equipment (e.g., Wang uses the Peripheral Band); and ease of moves and changes, which a broadband LAN allows with almost total flexibility.

8.2.3 Data Switch (DS) vs. Hybrid (Bb)

The comparative scores for Alternatives 1 and 4 are 688 and 767, respectively, with the Hybrid (Bb) Alternative 4 being favored. The comparative scoring of the detailed criteria for the Data Switch (DS) vs. the Hybrid (Bb) Alternatives is shown in Table 8-1.

There are no significant advantages of this alternative over Alternative 4.

TABLE 8-1. COMPARATIVE EVALUATION OF ALTERNATIVES MATRIX

	SCORING ALTERNATIVES				CRITERIA WEIGHT
CRITERIA ELEMENT	DS 1	bb 2	BB 3	Bb 4	WT
G/MOVES & CHNGS	60	60	**76**	72	80
T/FITS BUDGET	25	**32**	25	29	72
C/EXIST HDWARE	30	36	**48**	**48**	60
C/EXIST PROTOCL	**35**	**35**	**35**	**35**	50
G/TECH ADVANCES	25	43	38	**45**	50
P/AVAIL & RELIAB	**43**	41	41	**43**	48
P/CONCT & CONCUR	24	36	36	**38**	48
T/TIMING FITS	34	**36**	29	**36**	48
U/DAILY OPNS	**34**	32	30	28	40
U/MGMT CAPABIL	30	28	28	**32**	40
I/DISRUPTION	**30**	28	26	28	40
P/SECURITY	**31**	**31**	**31**	**31**	36
U/TRAINING REQ	**26**	22	24	21	32
U/DOCUMENTATION	**26**	24	22	21	32
I/PERSONNEL	**29**	28	27	26	32
C/EXIST PROCED	**23**	**23**	**23**	**23**	30
G/OPEN ARCHTCT	14	**27**	23	26	30
P/TRAFFIC CAP	16	18	**24**	**24**	24
P/TRANS SPEED	16	19	**22**	**22**	24

THE TOP SCORE(S) OF EACH CRITERIA ELEMENT IS IN BOLD FACED TYPE.

TABLE 8-1. COMPARATIVE EVALUATION OF ALTERNATIVES MATRIX (CONT'D)

	SCORING ALTERNATIVES				CRITERIA WEIGHT
CRITERIA ELEMENT	DS 1	bb 2	BB 3	Bb 4	WT
P/MEAS CAPABIL	**19**	18	17	**19**	24
P/FAULT CORR	**20**	19	19	19	24
C/POLICIES	10	15	14	**16**	20
C/EX PHS FACIL	**18**	12	8	10	20
C/AVAIL RESOURC	**15**	13	12	11	20
G/GEOG EXPANSN	15	16	14	**17**	20
G/INCR TRAFFIC	12	15	**20**	**20**	20
U/MAINTENANCE	**13**	12	11	11	16
P/ERROR RATES	**12**	**12**	**12**	**12**	12
I/INSTL & TRANS	**6**	**6**	5	5	8
TOTALS*	688	736	739	767	1000

THE TOP SCORE(S) OF EACH CRITERIA ELEMENT IS IN BOLD FACED TYPE.

*Note: Element scores are rounded to nearest integer. Total scores are sum of actual element scores rounded to nearest integer.

The disadvantages of this alternative compared to Alternative 4 are primarily in the following areas:

- o Moves and Changes....: this alternative received a score of 60 compared to a score of 72 for Alternative 4.
- o Existing Hardware/Software...: this alternative received a score of 30 compared to a score of 48 for Alternative 4.
- o Technical Advances...: this alternative received a score of 25 compared to a score of 45 for Alternative 4.
- o Connectivity and Concurrency...: this alternative received a score of 24 compared to a score of 38 for Alternative 4.
- o Open Architecture...: this alternative received a score of 14 compared to a score of 26 for Alternative 4.
- o Traffic Carrying Capacity...: this alternative received a score of 16 compared to a score of 24 for Alternative 4.
- o Increased Traffic...: this alternative received a score of 12 compared to a score of 20 for Alternative 4.

The primary reason for the scoring differences between the two Alternatives is 1) the expected flexibility of the baseband portion of the LAN to incorporate new technology, and 2) the compatibility of existing hardware/software with the broadband portion of the LAN, as described in the previous section.

8.3 BASEBAND (BB) - ALTERNATIVE 2

The primary characteristic of this alternative is its capability to allow simple interconnection between all workstation devices regardless of location or type of service to be provided.

The score that was received by Alternative 2 was 736 out of a possible 1,000 points. The range between the highest and lowest scored alternatives was 688 (DS), and 767 (Bb), or 79 points.

8.3.1 Baseband (bb) vs. Broadband (BB)

The comparative scores for Alternatives 2 and 3 are 736 and 739, respectively, with the Broadband (BB) Alternative 3 being favored, but not by much. See Table 8-1 for the side by side comparison of those two alternatives.

The advantages of this alternative compared to Alternative 3 are primarily in the following areas:

- o Fits Budget Cycle....: this alternative received a score of 32 compared to a score of 25 for Alternative 3.

- o Fits Timing Constraints....: this alternative received a score of 36 compared to a score of 29 for Alternative 3.

The disadvantages of this alternative compared to Alternative 3 are primarily in the following areas:

- o Moves and Changes...: this alternative received a score of 60 compared to a score of 76 for Alternative 3.
- o Compatibility with Existing Hardware/Software...: this alternative received a score of 36 compared to a score of 48 for Alternative 3.

The primary reason for the scoring differences between the two alternatives is one of balance between the different criteria. Moves and Changes are Alternative 3's primary advantage; ability to incorporate the most technical advances are Baseband's (bb's) primary advantage.

8.3.2 Baseband (bb) vs. Hybrid (Bb)

The comparative scores for Alternatives 2 and 4 are 736 and 767, respectively, with the Hybrid (Bb) Alternative 4 being favored. See Table 8-1 for the side by side comparison of these two alternatives.

There are no significant advantages of this alternative over Alternative 4.

The disadvantages of this alternative compared to Alternative 4 are primarily in the following areas:

- o Moves and Changes...: this alternative received a score of 60 compared to a score of 72 for Alternative 4.
- o Compatibility with Existing Hardware/Software...: this alternative received a score of 36 compared to a score of 48 for Alternative 4.

The primary reason for the scoring differences between the two alternatives is the ability of a Hybrid (Bb) LAN to take advantage of the particular strengths of the broadband component, namely a single building-wide backbone for ease of connectivity.

8.4 BROADBAND (BB) - ALTERNATIVE 3

The primary characteristic of this alternative is its capability to allow simple interconnection between all workstation devices regardless of location or type of service to be provided.

The score that was received by Alternative 3 was 739 out of a possible 1,000 points. The range between the highest and lowest scored alternatives was 688 (DS), and 767 (Bb), or 79 points.

8.4.1 Broadband (BB) vs. Hybrid (Bb)

The comparative scores for Alternatives 3 and 4 are 739 and 767, respectively, with the Hybrid (Bb) Alternative 4 being favored. Table 8-1 shows the side by side comparison of these two alternatives.

There are no significant advantages of this alternative over Alternative 4.

The disadvantages of this alternative compared to Alternative 4 are primarily in the following areas:

- Technical advances...: this alternative received a score of 38 compared to a score of 45 for Alternative 4.
- Fits timing cycle...: this alternative received a score of 29 compared to a score of 36 for Alternative 4.

The primary reason for the scoring differences between the two alternatives is an aggregation of many small points. The advantage of the Hybrid (Bb) over a pure broadband LAN is its ability to take advantage of the strengths of the baseband technology.

8.5 HYBRID (BB) - ALTERNATIVE 4

The primary characteristic of this alternative is its flexibility in using the best technical or operational solution for the wide variety of new interconnectivity requirements as they evolve.

The score that was received by Alternative 4 was 767 out of a possible 998 points. The range between the highest and lowest scored alternatives was 689 (DS), and 767 (Bb), or 78 points.

The comparative advantages and disadvantages of Alternative 4 versus each of the other alternatives have been discussed in the previous paragraphs.

8.6 COST COMPARISON

Table 8-2 presents net present value (NPV) costs for each of the alternatives. All figures are expressed in thousands of dollars.

TABLE 8-2. ALTERNATIVE LAN CONCEPTUAL COST* COMPARISON SUMMARY

ALTERNATIVE LAN	SEVEN YEAR NPV**
1. BASEBAND (bb) - ALTERNATIVE #2	$ 2,700
2. HYBRID (Bb) - ALTERNATIVE #4	$ 3,100
3. BROADBAND (BB) - ALTERNATIVE #3	$ 3,100
4. DATA SWITCH (DS) - ALTERNATIVE #1	$ 4,100

* All Figures in nearest hundred thousands of dollars

** Discount rate used in NPV model = 10%

The NPV is calculated over a seven year period (fiscal year 1988 through 1994). The costing analysis indicates that the least expensive alternative is the Baseband (bb) conceptual design at approximately $2.7 million. It is followed by the Broadband (BB) and Hybrid (Bb) designs, both at approximately $3.1 million. The most expensive alternative is the Data Switch, estimated to cost approximately $4.1 million.

CHAPTER 9. SENSITIVITY ANALYSIS

9.1 INTRODUCTION

A sensitivity analysis was performed on the differences between the four alternatives in terms of:

- o technical and performance scores; and
- o net present value costs for the seven year period through 1991.

The analysis of scoring differences and net present value costs is discussed in Sections 9.2 and 9.3 below.

9.2 TECHNICAL AND PERFORMANCE SCORING DIFFERENCES

The study team determined that a difference greater than 7 points could potentially be significant in the technical and performance scoring. The sensitivity analysis determined that:

- o there were no major differences between the Broadband and the Hybrid alternatives;
- o there were major differences in only 2 of 29 criteria between the Baseband and the Hybrid alternatives; and that
- o there were major differences in only 8 of 29 criteria between the Data Switch and the Hybrid alternatives.

The analysis between the Baseband and Hybrid alternatives is shown in Figure 9-1 and the analysis between the Data Switch and Hybrid alternatives is shown in Figure 9-2.

For the Baseband versus Hybrid comparison, the two criteria where potentially significant differences exist account for only 14% of the total score; the remaining 27 criteria account for 86% of the score. For the comparison between Data Switch and Hybrid, the eight criteria where potentially significant differences exist account for 33.2% of the score, while the remaining 21 criteria account for 66.8% of the score. However, of these eight criteria, only five appear to materially impact the scoring differences. There is a difference of 79 points (688 versus 767) between the scores of the Data Switch and the Hybrid alternatives. Of the eight criteria where potentially significant scoring differences exist, five criteria account for 76 out of 79 points.

FIGURE 9-1

SENSITIVITY ANALYSIS
BASEBAND VS. HYBRID

CRITERIA	WEIGHT	BASE BAND	HYBRID	DIFF.
GROWTH: Accomodation to moves and changes.	8%	60	72	12
COMPATIBILITY with existing hardware.	6%	36	48	12
ALL OTHER 27 criteria	86%	640	647	7
Total Points		736	767	31

FIGURE 9-2

SENSITIVITY ANALYSIS
DATA SWITCH VS. HYBRID

CRITERIA	WEIGHT	DATA SWITCH	HYBRID	DIFF.
GROWTH: Accomodation to moves and changes.	8%	60	72	12
COMPATIBILITY with existing hardware.	6%	30	48	18
GROWTH: Ability to include technological advances.	5%	25	45	20
PERFORMANCE: connectivity and concurrency.	4.8%	24	38	14
GROWTH: Open architecture.	3%	14	26	12
PERFORMANCE: Traffic carrying capacity.	2.4%	16	24	8
COMPATIBILITY with existing and planned physical facilities.	2%	18	10	-8
GROWTH: Provide for increased traffic flows.	2%	12	20	8
ALL OTHER 21 criteria	66.8%	489	484	-5
Total Points		688	767	79

Therefore, the sensitivity analysis for technical and performance evaluation comparisons indicates that although the study team selected and thought to be important 29 different evaluation criteria, the difference in the technical and performance evaluation scores is sensitive primarily to five criteria. These five evaluation criteria are:

- o accomodation to moves and changes;
- o compatibility with existing hardware;
- o ability to include technological advances;
- o connectivity and concurrency; and
- o open architecture.

The sensitivity analysis suggests that the technical and performance aspects of the selection of a local area network can focus primarily on these five criteria.

9.3 COST SENSITIVITY

Figure 9-3, Net Present Value Cost Comparison of Alternatives, reflects the seven year cost for each alternative through 1991. The cell entries indicate the difference in cost between the Hybrid and each of the other alternatives.

FIGURE 9-3. NET PRESENT VALUE COST COMPARISON OF ALTERNATIVES

	DATA SWITCH	BASEBAND	BROADBAND
	$ 4,100,000	$ 2,700,000	$ 3,100,000
HYBRID $3,100,000	$ 1,000,000	$ 400,000	$ 0

The cost shown for each alternative assumes that all 2170 workstations and 141 host controllers projected for fiscal year 1991 are interconnected. Each workstation is either directly connected to the network or indirectly connected via a host controller.

For instance, the Data Switch Alternative has 1324 workstations that are directly connected to the switch using network interface units (NIUs). The balance are connected to the switch via a host controller (which is connected to the switch by being directly connected to an NIU).

It should be noted that 50% of all direct data connections to the data switch are reserved for host/controller connections. Therefore, the Data Switch Alternative allowed for a total of 2000 data connections, 1324 from workstations and 674 of which are allocated to host/controllers (See growths and distribution migration reflected in Figure 7-1, Alternative 1 - Data Switch (DS) Growth Schedule).

A total of 2000 direct data connections was used as a limit for the Data Switch Alternative based on information received regarding the SL-100 capability to handle additional data lines without adding to the base cost of the switch, and the number of overall long term data lines allocated to Coast Guard.

The Hybrid Alternative has 2020 workstations directly connected to the network via NIUs, 236 from workstations to the Northern Telecom SL-100 switch (plus 164, approximately 50%, allocated for host/controllers) and 1784 to a combination of baseband and broadband cable. An additional 150 are connected via host/controllers for an overall total of 2170 workstation connections.

The Baseband and Broadband Alternatives also have 2020 workstations direct connected, including the same number (400) to the SL-100.

The cost of each LAN alternative is sensitive to many factors including the growth rate, the number of workstations connected to the network and the distribution of lines allocated to high, medium and low speed connections. Since all of the alternatives have the same growth rate (in terms of workstations and host/controllers) between now and 1991, the cost difference between alternatives is not sensitive to variations in overall growth rates.

The major difference in cost between the Data Switch Alternative and the three coaxial based alternatives is most sensitive to the mix and total of high, medium and low speed lines directly connected to the network, i.e., those that do not first go to a host/controller.

As summarized in Figure 9-4, Speed Connectivity Comparison of Alternatives, the Data Switch Alternative includes 730 high speed lines by 1991 (700 for Standard Terminals and 30 for Other Terminals) and 750 connected via host controllers. The Hybrid and Broadband Alternative have 1784 high speed lines by 1991, and 150 connections via host controllers. There are 1440 high speed lines in the 1991 Baseband Alternative, with 494 via host/controllers.

FIGURE 9-4. SPEED CONNECTIVITY COMPARISON OF ALTERNATIVES

Speed Connectivity	Number of Workstation Connections			
	Hybrid	Data Switch	Baseband	Broadband
High (above 64 kbps)	1784	730	1440	1784
Medium (9.6-64 kbps)	96	194	96	96
Low (below 9.6 kbps)	140	400	140	140
Connect, Via H/C	150	846	494	150
TOTALS	2170	2170	2170	2170

The cost difference between the Data Switch Alternative and the Hybrid is most sensitive to the number of high speed lines used.

The Hybrid includes approximately 1050 more high speed data connections for workstations than does the Data Switch. If for example the number of Data Switch Alternative high speed lines was to equal those of the Hybrid and they were added in 1991, they would increase the net present value cost of the Data Switch Alternative by almost $4 million dollars or approximately double the cost of the data switch conceptual design presented in this feasibility study.

Conversely, in order to bring the cost of the Data Switch Alternative to approximately equal the cost of the Hybrid Alternative, it would require that approximately 300 of the 730 workstations on high speed lines be removed and connected to the network via their host/controllers.

This is in contrast to the minimal cost differential involved in increasing a broadbadn or baseband connection from a low to a high speed connection.

As a point of reference, Figure 9-5, Speed Versus Transfer Time is presented to reflect the amount of time in seconds that the different speeds take to transfer a 250K byte file.

FIGURE 9-5. SPEED VERSUS TRANSFER TIME

	Low Speed below 9.6 kbps	Medium Speed 9.6 - 64 kbps	High Speed above 64 kbps
seconds	greater than 260	260 - 40	less than 40

The impact of changing the mix of network speed connections of the network could be significant from the perspective of the individual user. It would take more people more time to transfer data as the number of higher speed connections are reduced.

Sharply reducing the number of high speed workstations, for example, to bring the Data Switch Alternative cost approximately equal to the Hybrid, could pose a severe performance penalty to Coast Guard Headquarters, particularly if future database management policy emphasizes file transfer between workstations or to and from host/controllers (local or external to the Transpoint Building).

CHAPTER 10. CONCLUSIONS AND RECOMMENDATIONS

The study team recommends that the Hybrid (Baseband/Broadband) alternative be selected for implementing a USCG Headquarters LAN. This recommendation is based on the following factors:

- Localized Broadband and Baseband nets (e.g., Wangnet, Decnet) are already in place in Headquarters and the number of localized networks appears to be increasing. The Hybrid approach offers the greatest potential for interconnecting these existing networks as required and for providing access to outside services (e.g., the Transportation Computer Center's mainframe computer).

- The number and kinds of workstations in place at USCG Headquarters is changing. When compared to the Data Switch Alternative, the Hybrid Alternative (as well as the Broadband and Baseband alternatives) is not a sensitive to the mix and total number of high speed lines.

- The Hybrid Alternative received the highest technical and implementation score.

- The Net Present Value Cost of the Hybrid Alternative is within 16% of the lowest cost alternatives.

This concludes the main body of the Feasibility Analysis Report. The Appendices that follow in this volume and in Volume II of the report provide additional detail regarding the conduct of the study.

APPENDIX A

USCG LOCAL AREA NETWORK (LAN) STUDY WORKING GROUP MEMBERS/PARTICIPANTS

USCG LOCAL AREA NETWORK (LAN) STUDY
WORKING GROUP MEMBERS/PARTICIPANTS

o	CDR Benjamin M. Chiswell III (COTR) (G-TTS-2) Chief, Shore C Systems Branch Office of Command, Control and Communications	M
o	CDR Douglas F. Gehring (G-CAS) Assistant Chief, Administrative Services Office of Chief of Staff	M
o	LCDR David Frydenlund (G-DST) Information Resources Manager Systems Technology Division Office of Research and Development	M
o	LT Richard R. Kowelewski (G-MP) Marine Safety Information System (MSIS) Manager Office of Merchant Marine Safety	M
o	CWO Fred Courtney (G-TDS-3C) Standard Terminal Management Branch Office of Command, Control and Communications	M
o	Jack M. Ligon (G-TT) Technical Advisor Office of Command, Control and Communications	P
o	Lawrence M. Jasmann (G-APA-1) Chief, Administration Branch Office of Acquisitions	P
o	LT Robert D'Eletto Electronic Engineering Laboratory (G-LAB) U.S. Coast Guard Station Alexandria	P
o	Mr. Thomas Clark Electronic Engineering Laboratory (G-LAB) U.S. Coast Guard Station Alexandria	P

M = Member
P = Participant

APPENDIX B

SAMPLE USCG LAN FEASIBILITY STUDY INTERVIEW REQUIREMENTS UPDATE PACKET

UNITED STATES COAST GUARD HEADQUARTERS
LOCAL AREA NETWORKS (LAN)
UPDATE INTERVIEW

OFFICE: Comptroller (G-F)

CONTACT PERSON:

INTERVIEW DATE AND TIME:

INTERVIEW LOCATION:

NAME OF INTERVIEWEE:

Please review the attached material.

1. Pertaining to your office equipment, linkages and applications for 1985 and the future, and

2. Headquarters user requirements and system requirements, for discussion at the time and on the date indicated above.

Thank you for your assistance and participation.

FOLLOW-UP INTERVIEW
WITH COAST GUARD HEADQUARTERS PERSONNEL

Background: Wilson Hill Associates, Inc. is under contract with the U.S. Coast Guard (USCG) to conduct a Headquarters Local Area Network (LAN) feasibility study. The contracting officer's technical respesentative (COTR) is Commander Chiswell of The Shore C3 Systems (Of the Electronic Systems Division, of the Office of Command, Control and Communications.)

Purpose of Interviews: To up-date the user and system requirements for a LAN at Coast Guard Headquarters (CGHQ) developed in early 1985. Results will serve as a bases for identifying feasible LAN conceptional designs for the CGHQ environment.

Approach: Interviews will be conducted by Wilson Hill Associates, with a representative from each of the 13 CGHQ Offices involved in the 1984-85 Requirements Analysis Study. Each interviewee is provided with a copy of equipment and linkage results obtained from that study pertaining to their Office (attached). In addition, a copy of overall Headquarters findings for user and system requirements is included for review.

Please contact Lee Kerson at Wilson Hill Associates, 842-7732, should you have any questions prior to the interview.

I. EXISTING OFFICE EQUIPMENT AND LINKAGES

Primary Data Communications Equipment

Office data communications are served by clustered Standard Terminal and Wang equipment. The Standard Terminal workstations total 41 and are connected to 6 host/controllers. In addition, there are 3 Wang host/controllers with 34 Wang workstations.

Linkages and Other Data Equipment

Two of the Standard Terminal host/controllers have low speed modems attached for external communications. Several modems are used with the Standard Terminal workstations in one division's cluster for direct, external, low speed data communications.

One Wang host/controller is connected to similar Wang host/controllers located in Engineering and Command, Control and Communications.

Two of the Divisions utilize 2 Northern Telecom central processing units that have a total of 19 workstations connected in two clusters. The host/controllers have low speed modems attached for external communications.

The Office has five stand alone personal computers.

II. FUTURE PROJECTED OFFICE EQUIPMENT AND LINKAGES

The Office of the Comptroller projects a phased reduction in Wang equipment with all Wang workstations replaced by Standard Terminals over the next five years. All Northern Telecom workstations will be replaced by Standard Terminal workstations within the next two years.

The Office has increasing need for access to financial data within other Offices and is expected to require interhost/controller electronic access in the near term. By 1990, interhost/controller access from the Controller's Office to all Divisions/Branches in other Offices will be required not only for data access but also to support Coast Guard Headquarters electronic mail applications. File sharing is expected to be commonplace by then.

The external communication linkage requirements for Standard Terminal equipment in this Office will increase, especially for access to TCC and various other locations, as more of the Northern Telecom host/controllers and workstations are replaced by Standard Terminal equipment. This will require that the Standard Terminal host/controllers and workstations be equipped with higher speed communication ports.

III. PRESENT OFFICE COMMUNICATING APPLICATIONS

*Major Communicating Applications

Current	Future (Additional)
o FINAIDS	o HQ File Access
o Word Processing	o DOT Real Property System Access
o Various Report/Data Entry Applications	
o Field Support System	
o Resale MIS	

*Note: Does not include applications used solely within a cluster of terminals and their native host.

IV. FUTURE PROJECTED OFFICE COMMUNICATING APPLICAITONS

Data Communicating Equipment	Current *1985	Future 1986-87	Future 1990
Host/Controllers			
S/T - Host/Controllers	6	18	20
Workstations	41	180	200
Wang - Host/Controllers	3	1	None
Workstations	34	15	None
Northern Telecom			
Host/Controllers	2	None	None
Workstations	19	None	None
Others			
Personal Computers	5	15	18

*Existing or Planned for Installation.

V. EXISTING AND FUTURE PROJECTED OFFICE DATA COMMUNICATING EQUIPMENT

The Office of Comptroller operates several systems on Computer Sciences Corporation's time sharing service which is accessed from Standard Terminal equipment. In addition, FINAIDS, a major system, operates at TCC although presently without significant communications. A Wang system is used for exchanging word processing documents. It functions as the host of the Field Support System communications.

VI. SECTION 5. SYSTEM REQUIREMENTS

5.1 OVERVIEW

This study has determined that there are 38 major system requirements which must be satisfied for the CGHQ LAN. These requirements are subdivided into five related areas:

1. Environmental
2. Compatibility
3. Performance
4. Operational
5. Growth

Each area in some way impacts the others with varying degrees of influence. Together they represent those system requirements that are necessary for a Headquarters LAN. The Headquarters LAN user requirements, which include equipment connectivity and communicating applications traffic, are presented in Section 6, USCG Headquarters Local Area Network User Requirements.

Headquarters LAN refers to related administrative policy and procedures as well as hardware and software.

5.2 SYSTEM ENVIRONMENTAL REQUIREMENTS

Environmental requirements for a LAN define the physical and contextual setting for its operation. The environmental requirements, as defined here, include communciations policy and objectives, security and privacy, as well as the space and distance that the network must span.

Fourteen major environmental requirements have been determined for a Headquarters LAN and are listed as follows:

5.2.1 Policy and Objectives

The Headquarters LAN should:

1. Support the Coast Guard principle that information is an institutional resource. As a resource, information exists to support various levels of decision making. The LAN, therefore, should make information widely and readily accessible to users to support their productivity and promote effective and efficient Headquarters operations.

2. Function across autonomous Offices that have decentralized their decision making authority. To maintain each Office's autonomy while simultaneously contributing to Headquarters goals and objectives, the LAN must enable interoffice sharing of information.

3. Function at distributed data processing worksites which have personnel with wide ranges of teleprocessing maturity. The nature of the end user at Headquarters varies in sophistication. Offices also have uneven levels of budgeted resources for data processing/communications. Different users will generate various traffic loads to and from local and remote hosts. Traffic patterns change as users mature in their use of the network. The LAN should accommodate these different levels of use.

4. Transport data which is processed as a result of over 50 major communicating applications identified throughout Headquarters. The nature of the current and projected Headquarters transactions are such that they will include the entire spectrum from low volume, rapid response modes to high volume, delayed response transactions. Applications currently are mainly batch and interactive transactions. Message switching and bulk data transfer transactions are projected to be added in the near term (1986-87). The LAN must provide equal support for all the application transaction types described in Sections 2 and 3.

5. Provide access to increasingly available off premise "corporate" data bases. Information that will be of common interest across Offices will be stored in many central locations outside of the Transpoint Building, such as TCC and remote minicomputer locations worldwide. The LAN must enable users to communicate via gateways to remote data bases for file transfer and interactive type transactions.

6. Provide centralized data base control and maintenance of "corporate" data base integrity, based on Headquarters policies and procedures including record locking guidelines. A data base accessed by many

users across various Offices will require centralized management. The LAN should include software controls for access, data base changes and other restrictions for users. The LAN must also have a defined schedule for data base updates, programming revisions and other activities that would impact data base availability. Audit and record trails must be maintained to track changes made to the data base and its previous versions.

7. Provide centralized control of applications processing software package proliferation. Many users will be implementing the same software packages. Central control and record keeping of licensed software must be maintained to control costs and to limit potential infringements on license restrictions. The LAN must have indexes that identify all software available for Headquarters users and guidelines for their usage.

5.2.2 Security and Privacy

The Headquarters LAN must:

1. Restrict access to designated data bases and maintain privacy of information by allowing users entry on a need to know basis. The LAN must maintain information privacy through software access controls. The controls can be placed at the terminal, at network bridges or gateways, and/or at the data base itself. When files which involve privacy information are downloaded, procedures must be defined to control access to them on a need to know basis.

2. Provide for protected transmissions. There are no near term plans to utilize the Headquarters LAN for information that is classified. The LAN should be capable of being retrofitted to handle classified information when and if that requirement arises in the future. This could involve encoding/encryption of messages at either the terminal/workstation interface or at the interface with the network transport facility by an encryption system that is approved by the National Security Agency (NSA).

5.2.3 Physical Coverage

The Headquarters LAN must:

1. Provide an architecture that allows frequent moves and changes of workstation locations with minimal disruptiveness to office productivity. As discussed in Section 2.5, the CGHQ has a history of frequent organizational moves and changes. The moves and changes often require the rewiring of workstations to their host/ controller. Rewiring within the Transpoint Building is particularly costly for it requires 1) Installation by the building owner contractor and 2) Can take up to 90 days from submission of a work order to completion.

   The rewiring process also adversely impacts Headquarters worker productivity. The LAN must allow workstations to be easily moved from one location to another within the Transpoint Building. Moves must be accomplished without constant rewiring or disruption to the system or personnel.

2. Provide coverage for approximately 1) 400,000 square feet of office space in the six story Transpoint Building in Washington, D.C., and 2) 23,000 square feet of additional office space on two floors occupied by the Office of Health Services and a part of the Division of Data Services in G-T located in the Nassif Building, approximately one mile from Transpoint. The LAN must serve all Offices in CGHQ, providing access for and connectivity between, all personnel across all Offices.

3. Accommodate the possible exclusion of CGHQ from using overhead plenum for network wiring in the Transpoint Building. CGHQ does not currently lease the ceiling space in the Transpoint Building. An agreement will be required with the building owner for LAN installation and maintenance access. If an agreement cannot be developed, or is too costly, the LAN wiring will require an alternative plan.

4. Utilize existing building heat, ventilation and air conditioning facilities. The LAN must not require modifications to existing air handling facilities to operate as required.

5. Meet Federal and local building codes. In addition to satisfying leasing restrictions the LAN must meet all Federal and local building code standards.

5.3 SYSTEM COMPATIBILITY REQUIREMENTS

Three major system compatibility requirements have been determined for the CGHQ LAN:

1. Support a mixed vendor environment. The Headquarters LAN must provide various levels of connectivity to a mixture of 1) Standard Terminal host/controllers and workstations, 2) Wang host/controllers and workstations, 3) Other host/controllers and their workstations, such as PRIME Harris and DEC systems, (as described in Sections 2 and 3), 4) 3270 IBM emulation workstations, and, 5) A variety of different personal computers.

2. Provide physical and transport connectivity between all Headquarters workstations, in addition to supporting file access and electronic mail applications for data and message exchanges among users. The LAN must incorporate the necessary hardware and software protocols to provide users with file access and electronic mail services in the near term (1986-87). For the future (1990) it should provide presentation level protocols for potential graphics and videotex applications. No full motion video requirements are imposed on the LAN.

3. Provide multiple communications gateways to X.25 packet switching circuits, T1 leased lines, the building telephone system, and the Federal Telecommunications System. CGHQ users require access to the Nassif Building Amdahl computer and to various field and other remote data bases located throughout the world. The LAN must interface with wide area networks and local links for data communications external to the Transpoint Building.

5.4 SYSTEM PERFORMANCE REQUIREMENTS

Seven major system performance requirements have been determined for the CGHQ LAN.

The Headquarters LAN must:

1. Support point to point data processing equipment transfer rates of 1200 bps to, potentially, 4.27 megabits per second (Mbps). The transfer speed of Headquarters data varies. The speed depends upon the capacity of the data processing system being used. The LAN must support a minimum speed of 1200 bps for some communicating applications. Depending upon the LAN configuration design, the highest transfer rate that could potentially be required to be supported would be equal to the Wang system transfer rate of 4.27 Mbps per second.

2. Support both synchronous and asynchronous communications protocols. The bulk of Headquarters data communications is currently asynchronous. It is projected that synchronous communications will increase as access to the TCC Amdahl computer increases. The LAN must be capable of handling synchronous and asynchronous traffic.

3. Provide for input and output speed conversions. The different transfer speeds of the various Headquarters data communicating equipment will require the LAN to synchronize transfer rates. As data enters the network transport wiring from a device, and as it exits to a device, speed conversions will be needed.

4. Provide for multiple types of workstation session connections. The LAN must provide both single session and permanent virtual workstation connections in the near term. For the long term it is projected that multiple session concurrency must also be provided.

5. Provide resource addressability. The LAN software must have the capability for users to access resources by indicating 1) Specific resource address codes or 2) The nature of the resource needed.

The latter will allow the network management system to choose from among similar type resources that will satisfy the user request.

6. Provide additional response time delays of no more than one second for interactive type transactions. The LAN must not introduce a response time delay of more than one second over that which already exists between the time a user at a workstation initiates an interactive type transaction and the time a response is received.

7. Provide a quality of transmission that has an uncorrected bit error rate of 10^{-12} or better. The LAN must introduce a bit error rate of less than 10^{-12} or less than one bit error in the transmission of 10^{12} bits of data.

5.5 SYSTEM OPERATIONAL REQUIREMENTS

Eight major system operational requirements have been determined for the CGHQ LAN.

The Headquarters LAN must:

1. Provide ongoing system availability to all users. The LAN must be available 24 hours per day, 365 days of the year, except for maintenance. All system maintenance must be announced beforehand and be for periods of no more than 2-3 hours per month.

2. Provide for graceful degradation of the system should failure occur. The LAN must be configured so that one major failure will not immediately shut down the entire network.

3. Have a total network mean time to failure (MTTF) of no less than 10^5 hours. The LAN system must not fail more than once in 10^5 hours or approximately once every 12 years. The MTTF for an individual user should be no more than once in 10^4 hours or approximately once every 1½ years.

4. Have a network mean time to repair (MTTR) for outages/failures of less than one hour for the entire system. However, the LAN MTTR for an outage/failure that involves an individual user must be less than two hours.

5. Establish standardized recovery procedures. As part of the repair program to correct network outages/failures, the LAN must have a protocol established that directs how recovery of the network is to be carried out should the network or any part of it go down.

6. Be user friendly. The LAN must require no more than 1-2 days of training for end users. To train a system operator at the Office level must require no more than two days of training time.

7. Provide a centralized support resource to end users and system operators. The LAN must include a support element such as the Information Center concept to assist users in need of training, technical consultation and daily operational on call expertise.

8. Provide network management. The LAN must have a network control and monitoring system. The system must include the ability to check operating levels and carry out preventive maintenance programs.

5.6 SYSTEM MAINTENANCE AND REPORTING REQUIREMENTS

Four major system maintenance and reporting requirements have been determined for the CGHQ LAN.

The Headquarters LAN must:

1. Established a configuration managment program. The program must include documentation of network equipment, software, and the network configuration. It must also include user directories, configuration controls and reconfiguration procedures.

2. Maintain traffic statistics. The network maintenance program will require statistics on usage and performance including outages. The LAN must compile and provide management status reports on such indicators of performance as network reliability and availability.

3. Maintain user audit trails. A potential future requirement exists to charge back user or allocate network costs according to usage. Therefore, the LAN must include a user detailed recording system that will allow future cost sharing at the Office level.

4. Audit use of software packages. The LAN should include administrative procedures to record and track the use of licensed software application packages to ensure compliance with licensing restrictions.

5.7 SYSTEM GROWTH REQUIREMENTS

Two major system growth requirements have been determined for the CGHQ LAN.

The LAN must:

1. Be expandable and flexible. The Headquarters projections for workstation growth is for a near term increase of almost 50%. The LAN must allow for the anticipated increases in workstations. The LAN must also be flexible to accommodate the potential alternative ways in which workstations and host/controllers can be configured on the network. Therefore, the design must allow for 1) Growth in the number of end users, 2) Changes of location of end users and host/controllers within the Transpoint Building, 3) Projected increases in traffic volumes, 4) The mix of anticipated types of communicating transactions/applications, and 5) Increasing numbers and types of gateways and bridges.

2. Be able to incorporate future technologies. The field of local area networking is characterized by rapid changes in hardware and software technology. The LAN must be sufficiently modular and flexible to incorporate future protocols, applications, interface devices and other communications advances.

5.8 SUMMARY

The 38 major requirements discussed in this section constitute one set of parameters to identify the Headquarters LAN. They describe the system requirments. The second set involves user requirements. As mentioned previously, both sets are interrelated. Section 6, USCG Headquarters Local Area Network User Requirements, follows with an identification and discussion of the user Headquarters LAN requirements.

VII. SECTION 6. USER REQUIREMENTS

6.1 OVERVIEW

This section focuses on the user requirements that a LAN for Headquarters must satisfy to support current and projected estimates of data communications.

User LAN requirements are defined as those aspects of network operations that are most readily apparent to the workstation operator and most directly impact productivity. Three interrelated aspects of user requirements are discussed in this section:

1. Connectivity
2. Concurrency
3. Traffic Loading

Connectivity is the degree of access a user has to other user workstations or host/controllers. It defines the physical and logical connections the LAN must have.

Concurrency is a measure of the number of simultaneous users that are projected to be using the network.

Traffic loading refers to the volume of data the network is expected to transport measured in thousands of characters transmitted per hour.

The ideal LAN is conceptually simple. It provides: 1) Interconnection between each and every communicating workstation and host/controller, 2) The capability of all connections to transmit simultaneously, and 3) Unlimited data transfer rates among all devices.

The data collection and analysis activities presented in Sections 2, 3 and 4 provide realistic guidelines for connectivity, concurrency and traffic for a CG Headquarters LAN. The following sections describe each of these user requirements.

6.2 CONNECTIVITY

Over 1200 workstation devices are currently in use at USCG Headquarters. As shown in Table 6.1, User Workstation and Host/Controller Profile to 1990, this workstation population is projected to grow to almost 2000 by 1990. These devices must be physically or virtually connected to each other, either directly or via their respective host/controller, in order to support the communicating applications. As indicated in Section 5, USCG Headquarters Local Area Network System Requirements, one of the system requirements is the protocol conversion necessary for dissimilar devices to communicate to exchange data files and messages.

Table 6.1 - User Workstation and Host/Controller Profile To 1990

User Devices	Inventory/Projection Estimates 1985	1986-87	1990
Workstations	1219	1761	1958
Host/ Controllers	86	109	119
TOTAL	1305	1870	2078

During the early stages of implementation of a LAN (thru 1987) it is unrealistic to expect higher level protocol conversions to be implemented. The LAN requirement objective is to link 90% of Headquarters communicating workstations and their applications. This includes the Standard Terminal, Wang, IBM-3270 emulation, and RJE workstations. It also includes personal computers and VT-100 like workstations in "dumb" terminal emulation (ASCII) mode. These devices are projected to constitute 90% of the Headquarters workstations in 1987.

There are significant differences among the data communications characteristics of these various device types. For example, the Wang and 3270 type workstations require high data transfer rates with their host/controllers. The LAN transfer mechanism needed to accommodate these unique protocols and data transfer rates requires sophistication that is uncommon on present LANs. These needs will be taken into account during the LAN feasibility analysis and design stages.

The LAN for Headquarters must provide external connectivity (gateways and bridges) to other networks and LANs. Two external linkages pertain to CG Headquarters. One involves communication pathways to the Nassif Building. The other involves pathways to various locations throughout the world. By 1987, to support existing and projected communicating applications, the LAN must provide access to both types of external linkages from 90% of the workstations within Headquarters. It is projected that multiplexed leased telephone lines will serve as the linkage to the Nassif Building. A combination of X.25 packet switching ports, modem pool ports to the Federal Telecommunications System (FTS) and leased telephone lines will serve to connect users to worldwide locations. However, decisions on the specific types of linkages are to be determined based upon the feasibility study and design analyses.

6.3 CONCURRENCY

Concurrency refers to the number of simultaneous (or virtually simultaneous) connections the network must handle during normal operating hours. This is a statistical measure based on average and peak traffic loads. The maximum number of simultaneous users that any particular network can support depends primarily upon its bandwidth, switching capacity and the holding time of each user's connection. The greater the network bandwidth and switching capacity, the smaller the time delays experienced by users during peak traffic hours.

The actual percentage of concurrency of data communication connections existing or projected for USCG Headquarters has not been measured or quantified.

It is estimated that in 1985 a maximum of 10% of Headquarters workstations are ever used to communicate simultaneously. It is expected that as new devices and applications are added, that figure will increase to a maximum of 25% by 1990. Under these conditions of concurrency, the LAN must be capable of accommodating 500 simultaneous users by 1990. It is possible that the concurrency requirement could be exceeded if multiple sessions running on a single workstation becomes routine. However, insufficient data is available to calculate a more precise concurrency requirement.

6.4 TRAFFIC LOADING

Section 4, USCG Headquarters Traffic and Connectivity Analysis, presented estimates of current and projected USCG traffic workloads. Table 6.2, Peak Traffic Workload Profile To 1990, contains aggregated traffic estimates across all Offices and all workstations for the peak hour. The traffic loading analyses presented in Section 4 are based upon estimates of average traffic. Peak hour traffic for CGHQ is estimated to be two times greater than average hour traffic. To avoid potential degradation in the required network response time, the network must be designed to accommodate peak hour load traffic.
LANs have large traffic carrying capacities. Some types of LANs have a capacity greater than 100 million bits per second. The indicated peak USCG HQ traffic, converted to bits per second, is less than 5 million for 1990.

Although the individuals interviewed for this analysis did not express or foresee a prevailing need for graphic, facsimile or image transmission in the CGHQ, widespread introduction of these communications would significantly increase the data traffic volume beyond the estimate. Fortunately, concurrent with the introduction would be the installation of

sophisticated data compression hardware/firmware devices which would ameliorate the impact by providing a countervailing traffic volume reduction.

Table 6.2 - Peak Traffic Workload Profile To 1990

Year	Within Transpoint	Between Transpoint and TCC	Between Transpoint & Other Locations	Total
	---- Peak Traffic in Kilocharacters/Hour* ----			
1985	898,000	18,000	10,000	926,000
1986-87	1,408,000	28,000	14,000	1,450,000
1990	1,574,000	18,000	24,000	1,616,000

*Rounded to nearest thousand.

Total LAN traffic at Headquarters is a function of the LAN's particular architecture. If the network architecture includes local loops or clusters, traffic may never propagate into a single, commonly accessable data link and, therefore, the total traffic volumes may not be a very relevant measure of the LAN's traffic carrying capacity.

The LAN for CGHQ must be able to handle a minimum traffic volume of:

- Within Transpoint--1,574 million characters per hour
- Between Transpoint and TCC--18 million characters per hour
- Between Transpoint and other locations--24 million characters per hour

6.5 SUMMARY

This concludes the discussion of the user requirements for CGHQ. The three areas addressed, connectivity, concurrency and traffic loading are interdependent. A change in one impacts the others. Likewise, the system requirements are interdependent with user requirements. Together, the 38 system requirements presented in Section 5 and the user requirements presented in this Section, describe requirements that must be satisfied by a CG Headquarters LAN design.

APPENDIX C

LAN CRITERIA ELEMENTS WITH DESCRIPTIONS AND ASSIGNED WEIGHTS

APPENDIX C

DESCRIPTIONS OF EVALUATION CRITERIA

The following pages present a brief description/definition for each of the elements of the Evaluation Criteria for Alternative Local Area Network (LAN) Conceptual Designs.

SET - TECHNICAL

CLASS - HEADQUARTERS COMPATIBILITY

ELEMENT - Policies and Goals.

How well does the Alternative LAN fit within USCG Headquarters overall and long term telecommunication plans and policies?
Goal is to maximize the use of existing plans and to minimize contradictions and incompatibilities between plans and policies, and a LAN for Headquarters.

ELEMENT - Existing Operational Procedures.

How well does the Alternative LAN's operational procedures fit with established existing operational procedures?
Goal is to make maximum use of existing procedures and minimize changes to those that are established.

ELEMENT - Existing Hardware.

How well does Alternative LAN utilize existing workstations, host/controllers, and communications hardware?
Goal is to maximize use of existing hardware and to minimize undesired abandonment of Standard Terminals, Wang, and other existing hardware.

ELEMENT - Existing Communications (and OS and Applications) Software.

How well does the Alternative LAN's communication software fit into existing communication system and related software?
Goal is to maximize use of existing communications and related software and minimize purchase/development of new software.

ELEMENT - Existing and Planned Headquarters Physical Facilities.

How well does the Alternative LAN fit the constraints of existing and future Headquarters facilities plans?
Goal is to minimize the number of incompatibilities with contractual and planning constraints as well as to maximize the use of the existing/approved facilities environment.

ELEMENT - Available Personnel Support/Resources Staff.

How well does the Alternative LAN's operating staff required resources fit into Headquarters plans for use/assignment of support staff and contract support?
Goal is to maximize the fit of staff resources within Information Resource Management (IRM) plans, and to minimize modification and adjustments to plans for data base management and wide area networking to match LAN operation.

SET - TECHNICAL

CLASS - NETWORKING SYSTEM PERFORMANCE

ELEMENT - Availability/Reliability.

What level of availability can the Alternative LAN be expected to achieve?
Goal is to maximize both total system and individual user workstation/application availability. The availability of both the total system and individual interfaces/links must exceed specified minimum down time and other outages, and minimum recovery/restoration times.

ELEMENT - Connectivity/Concurrency.

To what degree will the Alternative LAN provide complete workstation and host controller interconnectivity, and at what level of concurrency and multiplicity of sessions?
Goal is to maximize both connectivity of equipment and concurrency of sessions/transactions.

ELEMENT - Traffic Carrying Capacity.

What level of total traffic can the Alternative LAN carry?
To be considered as an Alternative LAN the configuration capacity must first exceed the traffic requirements previously determined and specified as a Headquarters requirement.
Goal is to maximize the potential traffic carrying capacity of the network, including a mixture of low speed, medium speed, and high speed synchronous and asynchronous traffic in various communication protocol formats. Goal is also to minimize the restrictions on the amount and type of traffic the LAN can carry and allow, for example, the use of multiple types of modulation simultaneously.

ELEMENT - Transmission Speed/Response Time.

What transmission speeds are supported by the Alternative LAN, and on what communication protocol formats? This element is related to traffic carrying capacity and, in toto, is a determinant in user observed delay times, both in interactive and in bulk or file transfer applications.

Goal is to maximize support of multiple, sessions, connections, and types of transmissions in a user transparent manner. Goal is also to minimize user restrictions and waiting time.

ELEMENT - Error Rates.

What level of uncorrected and corrected error rates will the Alternative LAN introduce?
Goal is to minimize the introduced system errors and the resulting corrected errors. Certain types of corrected errors should not be considered prejudicial if guaranteed delivery access methods do not degrade system performance significantly. Goal is to maximize error free end to end transmissions.

ELEMENT - Measurement and Control Capability.

What level of system configuration control, operation, recovery, and restoration is available in the Alternative LAN?
Goal is to maximize the control and flexibility of the LAN system management and to provide fast, reliable support to users. Goal is also to minimize complexity of operation and maintenance of LAN system, as a whole.

ELEMENT - Security Levels Achievable.

What degree of security can be provided for users of the Alternative LAN? Security capability at a DOD classified level is not a Headquarters requirement, but the capability to add this is desirable. A privacy level of security is required. Both hardware and software security solutions, or combinations, are acceptable.
Goal is to provide maximum security/privacy within a reasonable level of user ease-of-use and system operability. Capability to migrate into classified operation is a goal. Goal is also to minimize difficulty of LAN system interfacing for users not requiring security.

ELEMENT - (Provide) Fault Correction Capabilities.

How well can the Alternative LAN handle component, subsystem, software, and externally induced system and individual work-station connection failures?
Goal is to minimize the down time and the loss of information in transit. Goal is also to maximize the number of variety of fault types that can be corrected by the LAN system.

SET - TECHNICAL

CLASS - EASE OF USE

ELEMENT - Required Training.

How much end user and system operator initial and ongoing training is required to use the Alternative LAN?
Goal is to have a simple operational LAN that requires minimal

training. Goal is also to maximize the services that can be provided to the end user with the minimum amount of training.

ELEMENT - Daily Operations.

How much time and effort is required to provide support for the communications facilities of the Alternative LAN?
Goal is to minimize the support time and complexity of operation so that users do not have to be aware of the presence of the LAN.

ELEMENT - Quality of Documentation.

How lucid, complete, and correct is the documentation provided with the Alternative LAN system?
Goal is to minimize the frustration of both end users and system operations personnel because of unintelligible and misleading LAN system documentation. Goal is also to maximize use of the LAN as a useful service by providing "user friendly" human interface information.

ELEMENT - Ongoing Maintenance.

How much ongoing maintenance effort is required to keep the Alternative LAN system in full operational use?
Goal is to minimize both the time required by the system operator to maintain the system (and each subsystem) and to minimize the skill level of the personnel required to maintain system operation.

ELEMENT - Control, Management, and Configuration Capabilities.

What degree of system management does the Alternative LAN provide? For example, can interfaces/workstations be readily added, moved, and renamed? How much system and user data can be collected for analysis and how easily is the network control accomplished?
Goal is to minimize the level of effort and the skill level of the staff required to accomplish system management. Goal is also to maximize the usefulness of communications system management and to provide flexibility and expandability.

SET - TECHNICAL

CLASS - GROWTH CAPACITY

ELEMENT - Accommodation to Moves and Changes.

How well can the Alternative LAN provide quick and flexible interconnectivity to users whose workstations and server resource locations have been relocated?
Goal is to minimize the delay or waiting time by users for

services, and to minimize the work and cost required to accomplish this task.

ELEMENT - Allow Incorporation of Technological Advances.

How well does the Alternative LAN conform to accepted standards? Goal is to allow the addition of non-vendor specific hardware and software products that are state-of-the-art, and which provide new, expanded and enhanced capabilities as they become available in the future.
Goal is also to minimize the dependence of the USCG Headquarters upon single vendor solutions that could preclude the use of industry wide evolving advances in both communications and applications software and hardware. Goal is to minimize the restrictions upon potential future migration toward higher performance/lower cost capabilities for upgrades.

ELEMENT - Provide for Geographic Expansion.

How well can the Alternative LAN provide service to new locations that are presently not served by the LAN?
Goal is to minimize the delay in obtaining new services at new locations and to minimize the work and cost to accomplish this task.

ELEMENT - Provide for Increased Traffic (Flow).

How readily can the Alternative LAN provide services that require large increases in the volume of traffic on the network? This increased flow may derive from new users, new applications, or increased use of the network by existing users.
Goal is to minimize the rework of the LAN necessary to accommodate future traffic increases and to maximize the ultimate traffic capacity.

ELEMENT - OPEN ARCHITECTURE

How well does the Alternative LAN conform to some set of the Open Systems Interconnection Concept (OSI model) which provides a framework for standards for linking heterogeneous computers and terminals. Specifically, how well will the LAN allow and support interconnection of devices using differing communications protocols? The various IEEE 802 lower-level protocols (1 thru 3) must be supportable.
Goal is to minimize the dependency of the LAN system upon proprietory protocols and to use emerging industry standards for interconnection whenever possible. Goal is to maximize the variety of selection of both existing and new alternative technical solutions for interconnectivity.

SET - IMPLEMENTATION

ELEMENT - Congruency with other Related Plans.

How well does the Alternative LAN fit into other USCG Headquarters telecommunications related plans from a timing viewpoint? Implementation plans are to be used to judge the flexibility of the Alternative LAN's installation, transition to operation, and upgrading path procedures.
Goal is to minimize rigid timing constraints upon the implementation of either the LAN or any related system. Goal is also to maximize the flexibility of implementation timing.

CLASS - TIMING

ELEMENT - Fit Within Fiscal Budget Cycle.

How well does the Alternative LAN's implementation fit within the USCG budget cycle?
Goal is to maximize the flexibility with which the LAN can be phased in to fit into available funding.

ELEMENT - Demands Upon Headquarters Personnel.

What level of demand upon USCG Headquarters personnel is required by the Alternative LAN?
The goal is to have a straight forward implementation plan that minimizes the Headquarters staff time required to plan and administer it.

ELEMENT - Degree of Disruption to Critical Operations.

What critical operations will be disrupted, if any? What is the magnitude of any identified disruption? What impact will the disruption(s) have on the Headquarters? Which specific functions, offices, and/or activities will be affected?

ELEMENT - Duration of Installation/Transition.

What is the duration of the initial installation phase?
How are the various components of the Alternative LAN required to be implemented?
Goal is to maximize the flexibility of installation so as to fit the USCG Headquarters external constraints.

SET - COST/FINANCIAL

CLASS - ACQUISITION

Will consist of materials and labor categories for capital purchases and conversion/cutover costs.

CLASS - RECURRING

Will consist of materials and labor categories for operations and maintenance.

APPENDIX D

GLOSSARY FOR LOCAL AREA NETWORKS

APPENDIX D. GLOSSARY

ANSI	-	American National Standards Institute. The principal standards forming body in the USA. Non-profit and non-government. USA's member body to ISO.
Backbone	-	The main, high capacity, central communications path of a communications network.
Bandwidth	-	A measure of frequency use or information carrying capacity. Voice transmission requires 3 to 4 KHz. A TV channel occupies a bandwidth of 5 to 6 MHz; (5 MHz is the European standard, and 6 MHz is the American standard).
Baseband LAN	-	Typically, a network operating in the 0 to 10 Mbps speed range; transmission speed is one of the basic references in characterizing a family of LANs. Baseband, like broadband, also describes bandwidth equipment, or systems that can carry a large portion of the electromagnetic spectrum.
Broadband LAN	-	Usually, an industry standard CATV distribution network providing digital channels using modulated RF carriers. Typically, a broadband network consist of an analog information distribution system permitting both digital services and conventional analog information services. These coexist on the same cable system.
Bus	-	The connection of network nodes, as in a baseband system, to a linear length of cable to which user stations are attached by network interface units.
Central	-	A technology that typically uses circuit switching, a star topology and a dedicated path for each distributed user.
Conceptual LAN Design	-	A local area network defined in terms of 1) the general technology to be employed in its architecture (e.g., - baseband, broadband), 2) estimated numbers of devices to be attached, grouped into broad categories (e.g. - workstations, host/controllers), and 3) issues that

must be addressed to enable devices to communicate, both within the network and to external locations (e.g., protocols, gateways). The conceptual LAN design is preliminary to the detailed design which includes refined functional and performance, (hardware and software) specifications of both the overall network and individual types of device attachments.

Convergent Technology - The manufacturer of the Standard Terminal used at Coast Guard Headquarters.

Coaxial Single Cable (Ethernet) - A bi-directional electronmagnetic transmission medium consisting of a center conductor and an outer, concentric conductor, used in this report to refer to Ethernet baseband communications.

Coaxial Dual Cable - Two single uni-directional coaxial cables used to transmit data on baseband. Refers, in this report, to the connections between a Wang host/controller and its attached workstation.

Distributed - Distribution of data (and text) regionally (on minis), locally (on LANs), or at the personal workstation level (microfiles) to make text and data easily accessible by the user; that is, at the workstation.

EIA - Electronic Industry Association (EIA). A trade organization representing a large number of U.S. electronics manufacturers. Has over 4000 government and industry representatives. EIA has produced over 400 standards and publications.

Ethernet - Originally, a proprietary, Xerox, DEC and Intel baseband LAN which generated the CSMA/CD IEEE 802.3 standard.

Hybrid LAN - A combination network made up of broadband and baseband LAN technologies.

IEEE - Institute of Electrical and Electronics Engineers. An American based organization that actively establishes standards

for the data communications industry, among a great many other activities. Its most well known effort is Project 802 which is attempting to define local area network (LAN) standards.

ISO - International Organization for Standardization. A non-treaty organization comprised of 90 member nations. ANSI is the USA's member body to the ISO.

Minicomputer - A computer with an 8, 12, 16, 18, 24 or 32 bit word length. Used in this report to refer to Coast Guard Headquarters PRIME, DEC, Harris and Wang computers.

Multi Drop - A connection by which several nodes share the same communications link, but only one node can transmit at a time.

Network Interface Unit (NIU) - A device that interfaces the user device with the network transport media, both electrically and functionally.

OSI - Open System Interconnection. ISO's seven layered Reference Model consisting of:

Layer	Name
7	Application
6	Presentation
5	Session
4	Transport
3	National
2	Data Link
1	Physical

Personal Computer - A microprocessor based unit, such as an Apple or IBM PC, with a central memory, typically ranging between 64Kb and 1Mb, with soft and hard copy facilities and floppy and/or hard disk storage.

Port - A socket to which a user device attaches; a point of access. Each port has a separate identifying address.

Protocol - A rule of conduct. The procedure for ordering the exchange of formatted information packets between correspondents. A set of rules for communicating. Protocols are interpreted by means of both hardware and software. They may be layered, with each side of the protocol achieving capability with its adjacent layer and a common conversion.

RS-422 - See RS-449, below. RS-422 is a subset of RS-449.

RS-449 - A 37-pin EIA interface standard which defines the electrical and mechanical characteristics for connecting Data Terminal Equipment (DTE) and Data Communication Equipment (DCE) using serial binary data communication. RS-449 is intended to eventually replace the familiar RS-232-C standard. RS-449 and its companion standards were developed to permit an orderly transition from existing equipment using RS-232-C to a newer generation of equipment using RS-449 without forcing obsolescence or costly retrofits. However, RS-232-C remains the most common interface because most U.S. manufacturers have embraced the older standards.

RS-449 operates in conjunction with either of two standards specifying electrical characteristics: RS-422-A, for balanced circuits; and RS-423-A, for unbalanced circuits. When neither side of the circuit is grounded, the circuit is balanced. When the circuit uses a common or shared grounding technique, it is unbalanced. RS-232-C is an unbalanced interface, as are the coaxial cable networks. The advantage of a balanced circuit is the reduction of elimination of common ground loop spurious signals.

RS-232-C - A 25-pin EIA interface standard which defines the electrical and mechanical characteristics for connecting Data Terminal Equipment (DTE) and Data Communication Equipment (DCE) using serial binary data communications. RS-232-C is the most widely used DTE to DCE

interface in the USA. It applies to all classes of service: private line, dial-up, point-to-point, multipoint, switched, non-switched, two-wire, and four-wire service. Asynchronous and sychronous data transmission is supported at speeds up to 20 kbps in full or half-duplex mode. RS-232-C is a single ended or unbalanced interface.

Server - A shared resource, using a software driver dedicated to specific functions. A LAN typically has a file server, print server, and communications server (gateway).

Topology - The geometrical connectivity oriented arrangement of computer resources, remote devices, and communications facilities. The structure consists of links and nodes. Connectivity is provided by either circuit or packet switches at the nodes.

Tree - A topology in which stations are attached to a shared transmission media, such as in a broadband system. The transmission medium is a branching cable emanating from a headend with no closed circuits. Transmissions propagate throughout all branches of the tree and are received by all stations.

Twisted Pair - An electromagnetic transmission medium consisting of two insulated wires arranged in a regular spiral pattern, characteristically used in telephone systems to minimize noise, pickup and crosstalk.

Wang - A major offices system, computer system and network manufacturer.

WangNet - Wang Laboratories, Inc's, proprietary, dual cable, broadband LAN. WangNet supports multiple communications channels for host to workstation connections, host to host connections, and other switched and point-to-point communications service. These latter two may be provided by Ethernet type distributed switching (datagram or virtual connection service) or by dedicated frequency division multiplexed channels.

APPENDIX E

OTHER CANDIDATE ALTERNATIVE LAN CONCEPTUAL DESIGNS

APPENDIX E
OTHER CANDIDATE ALTERNATIVE LAN CONCEPTUAL DESIGNS

E.1 OVERVIEW

This appendix provides a brief description of other conceptual LAN approaches that were considered for the Coast Guard Headquarters LAN and eliminated from further consideration because they are deemed to be outside of the competitive range.

Eight potential alternatives were originally conceived. Four have been refined and will be carried forward to the evaluation stage. They are described in the main body of this report. The alternatives eliminated are discussed below together with the rationale for their rejection.

E.2 REVIEW OF THE POTENTIAL ALTERNATIVES

A matrix of the original eight alternatives is shown below, Figure E-1, Summary Chart of Potential Alternatives. The matrix reflects the three major technologies involved; data switch (DS), baseband (bb), and broadband (BB).

The numbers in each cell of Figure A-1 indicate the Alternative that incorporates the technologies listed. The alternatives numbered #1 -#4 are those selected for evaluation, e.g., the Data Switch is Alternative #1; the combination of bb and BB constitutes the Hybrid Alternative #4. The alternatives that were eliminated have their numbers shown in parenthesis ( ), i.e., #5 -#8.

FIGURE E-1, *Summary Chart Of Potential Alternatives**

Transport Variable	DS	bb	BB
DS	#1	#2	#3
bb	#2	(#5)	#4 (#7)
BB	#3	#4 (#7)	(#6)

*Alternatives #1 - #4 all have a data switch component.

Alternative (#8) is an unconstrained mix of all three technologies.

Each of the four eliminated Alternatives (#5 - #8) are discussed in the sections that follow.

E.3 ALTERNATIVE #5: VENDOR-SPECIFIC AND/OR UNCONSTRAINED BASEBAND NETWORKS

This Alternative includes two types of baseband networks; vendor-specific and unconstrained systems.

The vendor-specific networks, (e.g., DECNET or one of the many other microcomputer baseband local area networks) do not completely comply with ISO protocols and interconnection standards, such as 802.3. They were also eliminated because of the limited support there is for them in the industry and the difficulties of compatibility with existing and projected Headquarters devices. Ethernet, on the other hand, is widely supported by other vendors and is more highly compatible with Headquarters equipment.

Unconstrained use of a multitude of LANs was rejected because this approach would be basically unsupportable via a centralized network management and control system, and would introduce

burdensome manpower training requirements. Users who choose nonstandard baseband networks must be prepared to operate in an unsupported environment. This is not acceptable for the Headquarters environment.

E.4 ALTERNATIVE #6: VENDOR-SPECIFIC AND/OR UNCONSTRAINED BROADBAND NETWORKS

This alternative includes the same two types of networks discussed in Alternative #5, i.e., vendor-specific and unconstrained.

Vendor-specific broadband networks such as Sytek Local Net 20, IBM PCNet, and TRW Net 2000 are considered too limited in their capabilities. Others, such as 3M, have a token passing broadband network; and Ungermann-Bass's Net One supports 802.3 baseband protocols, but only at a reduced transfer speed.

The broadband backbones of most vendors operate over a single rather than a dual cable. Wang, at present, is the only vendor that operates using a dual cable broadband backbone.

Arguments for elimination of this Alternative are similar to those used for Alternative #5. A multitude of vendor-specific broadband backbones and/or network interface units would make the LAN difficult to configure and manage. A single dual cable broadband backbone to support all known requirements (for the broadband backbone based alternatives) was selected for uniformity and to accomodate the Wang devices which represent approximately 25% of the Headquarters host/controllers and workstations.

E.5 ALTERNATIVES #7 AND #8: VENDOR-SPECIFIC AND UNCONSTRAINED HYBRID BASEBAND PLUS BROADBAND (AND DATA SWITCH) NETWORK

These two alternatives include baseband/broadband hybrid networks, both with and without data switch support. The rationale for elimination of these alternatives is again similar to that for the unconstrained and vendor-specific baseband and broadband LANs.

In general, vendor-specific hardware and software should be avoided in favor of standard intra-LAN protocols. Failing that, because of compatibility requirements with existing devices and applications, a very limited set of non-uniform support should be included on the network(s). The variety of communication hardware and software should include standard devices and should support ISO protocols. At this time, the IEEE 802.3 and X.25 protocols appear to be the best candidates for use in building a LAN that will satisfy Headquarters requirements.

E.6 LAN TRANSMISSION MEDIA

Fiber-optic cable, as opposed to coaxial cable for broadband transmission, is technically a viable alternative. At present however, the input/output devices for local area networking are not readily available at costs competitive with those used on coaxial cable. However, depending upon the topology chosen, a fiber-optic backbone might well become competitive with a couple of years. At the time of the preparation of a request for proposal, the bidders should be allowed to submit designs that incorporate fiber-optic cable.

E.7 SUMMARY

The synthesis and analysis of candidate conceptual alternative LAN designs was not limited to baseband, broadband, and data switch technologies. Other potential methods of local area networking such as infra-red or radio frequency wireless communication were also considered. However, because of their high susceptibility to spurious disconnection and to interception, high error rates, and low reliability characteristics, they were not explored. At this time they cannot satisfy Headquarters requirements. Similarly, interconnection via carrier equipped transmission through building wiring was eliminated from further consideration.

Inter-building connections via microwave, broadband coaxial-cable, or optical fiber links was considered and rejected. Although they are well developed and reliable technologies, it is considered extremely unlikely that they would be cost effective, given that there will be inter-building T-1 linkage via the SL-100 PBX.

APPENDIX F
MAJOR LAN COST ASSUMPTIONS

APPENDIX F

MAJOR LAN COST ASSUMPTIONS

The following is a list of the major cost assumptions used to estimate the net present value cost per each alternative LAN.

- o Net present value discount rate: 10%
- o Installation of: twisted pair wiring, including materials: $150/100 feet
  - Dual cable wiring, including materials: $500/100 feet
  - Baseband single cable coaxial wiring including materials: $500/100 feet
  - Low speed NIU for data switch communications including line card and materials: $825/unit
  - Medium speed NIU for data switch communications including line card materials: $1,200/unit
  - High speed NIU for data switch communications including line card and materials: $1,500/unit
  - High speed switch: $2,000/connection
  - Baseband NIU including materials: $400/unit
  - Baseband bridge including materials: $600/bridge connection
  - Baseband gateway including materials: $800/gateway connection
  - Broadband NIU including materials: $450/unit
  - Broadband bridge including materials: $675/bridge connection

- Broadband gateway including materials: $900/gateway connection

- Central bridge including materials allocated to a module: $500/module

- Central gateway including materials allocated to a module: $1,000/module

o Cutover/conversion: 15% of capital acquisition

o Operations and maintenance: 5% of captial acquisition.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